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METHODS OF THE SANTA FE. EFFICIENCY IN THE MANUFACTURE OF TRANSPORTATION.

By Charles Buxton Going.

I. PECULIAR PROBLEMS OF THE ROAD, AND THEIR SOLUTIONS.

The Santa Fe methods, or their results, have attracted wide attention. Railway officials from the very greatest American roads, shop men from manufacturing plants, and technical specialists, have gone to study the system. Certain parts of the practice have been ably presented in the engineering press, notably in Mr. Jacobs' series on "Organization and Economy in the Railway Machine Shop," published in this magazine, Sept. 1906 to Jan. 1907. The purpose of the forthcoming articles is to define all the great features of the Santa Fe problem affecting the manufacture of transportation. They are designed to give a broader view than has yet been afforded of the policy underlying the work, the results secured, and their meaning for the future of transportation in the United States, so far as concerns not only the railways but the shippers and the manufacturers of the country.—THE EDITORS.

THE relation of the railroads of the United States to its industries—the effect of their welfare upon financial, commercial and manufacturing conditions, and especially the correct solution of the problems of economical and profitable transportation—have assumed an importance that makes the study of a leading case not only appropriate to THE ENGINEERING MAGAZINE, but imperative. The Santa Fe, in common with all American roads, has experienced difficulties arising from progressive decrease in rates collected per ton mile and per passenger mile, and from increased expenditures necessitated by rising standards of service performance. Beyond this, it has peculiar individual difficulties caused by its mileage, grades, desert environment, fuel, water and labor conditions. We often find in history that great situations have developed great leaders, and a similar effect is apparent here. Under the chief operating officials, policies and methods have been inaugurated and perpetuated by which

the necessary margin between operating costs and operating revenues has been secured and is being widened, with increasing liberality to employees and without increasing charge to patrons. In short, the third way of forcing into parallel the converging lines of cost and compensation in railroad operation (recently referred to in the editorial columns of this Magazine) is successfully applied. In its application there have been developed shop methods, mechanical and manufacturing practice, and relations with employees, which are not only abreast, but in advance, of many of the standards reached even under the keen stimulus of competitive manufacturing conditions.

The chief of these features are:

First, boldness in the adoption and design of engine types suited to the very heavy service of the road, energy in effecting every revision of line and grade which will permit heavier loads to be hauled, and constant effort to load every engine to its full average rating.

Second, the centralization of manufacturing at the most advantageous points, the standardization of tools, operations, and parts, and the stimulus to workmen and foremen provided by a bonus system based on efficiency. These constitute what is generally termed the "betterment work," and combined with special measures for the oversight and handling of the engines on the road and in round-houses and shops, and with a remarkable management of the stores department, they secure high results in the average condition of engines in service, and the repair of power at low cost and with a minimum of detention from the road.

Third, an organization and supervision of the stores system which is unique in its conception and results. This department, far from being a mere clerical bureau, or depository of records, becomes in many respects a leading and a driving force to the mechanical and operating departments.

Fourth, a department of tests serving on one side for routine assistance and instruction to the purchasing and stores departments, and on another side for impartial and thorough experiment and advice on new devices. Collateral and co-ordinate with this, a chemical department serving similarly for chemical inspection or examination of all materials, and originating methods and appliances for new work—as shown conspicuously, for example, in the water-treating plants hereinafter described.

Fifth, a broad-minded and generous provision for the comfort and benefit of employees, caring for their pleasure and satisfaction

in and out of working hours while in the service of the road, and extending a voluntarily granted pension on their retirement.

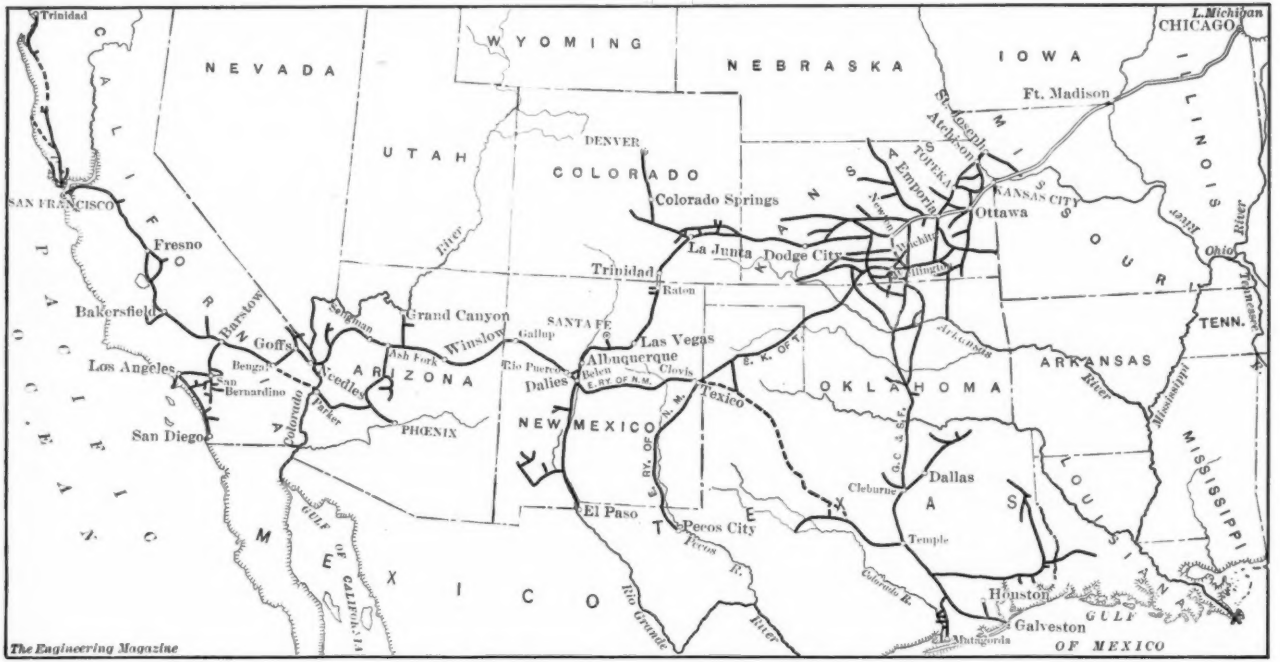
Sixth, a comprehensive and excellently-planned system of apprentice instruction, training up new first-class material for the shops of the road, and solving that often perplexing problem of the "mechanic of the future."

The order in which these features are listed is not intended to express any estimate of their comparative importance. Indeed, the institutions are so intertwined that it would be hard to say which is greater than the others. Each is in some degree dependent on all; each in turn contributes something more to the success of all. It is with these elements of the Santa Fe management, all of them closely sympathetic with, and many of them applicable to, the ordinary mechanical or manufacturing plant, that these articles will especially deal. Before taking them up in fuller detail, however, a short outline of the situation and the controlling conditions on the line of the Santa Fe will help to make clear the circumstances under which these policies have worked to success.

The configuration of the system is roughly that of a nearly equilateral triangle with sides about 800 miles long and angles resting at Kansas City, Albuquerque (New Mexico) and Temple (Texas). From the corners of this triangle, three great stems extend—eastward to Chicago, southward to Galveston, Houston and Matagorda, westward to Los Angeles, San Francisco, and up the Pacific Coast. The northwesterly angle is overlapped by a spreading network of branches covering the rich agricultural sections of Kansas, Oklahoma, and northern Texas, and similar expanding networks cluster about the gulf and Pacific Coast terminals. The southwesterly side of the triangle is still open*; but crossing it and forming substantially a continuation of the Chicago-Kansas City main stem, is the Pecos Valley division, reaching a fertile and rapidly-filling section of southern New Mexico, while other important lines extend from the westerly angle (at Albuquerque) to El Paso, connecting the Mexican railways, and from the middle of the northerly side (at La Junta) to Denver.

The total mileage is about ten thousand—the longest under a single management in the United States. It is nearly twenty-six hundred miles from Chicago to San Francisco, nearly a thousand from Kansas City to Galveston, five hundred from Kansas City to Pecos. The transcontinental line, however, especially attracts interest, and it is to it that the observations embodied in this article particularly apply.

* The line from Texico to Brownwood, Texas, closing this gap, and making a direct through line from San Francisco to the Gulf ports, will probably be completed this year.



OUTLINE MAP OF SANTA FE SYSTEM.

The lines directly operated by the corporations of the Santa Fe System cover 7,900 miles. The Southern Kansas Ry. of Texas, the Eastern Ry. of New Mexico, and the Gulf, Colorado & Santa Fe, which have separate corporate organizations, aggregate 2,177 miles.

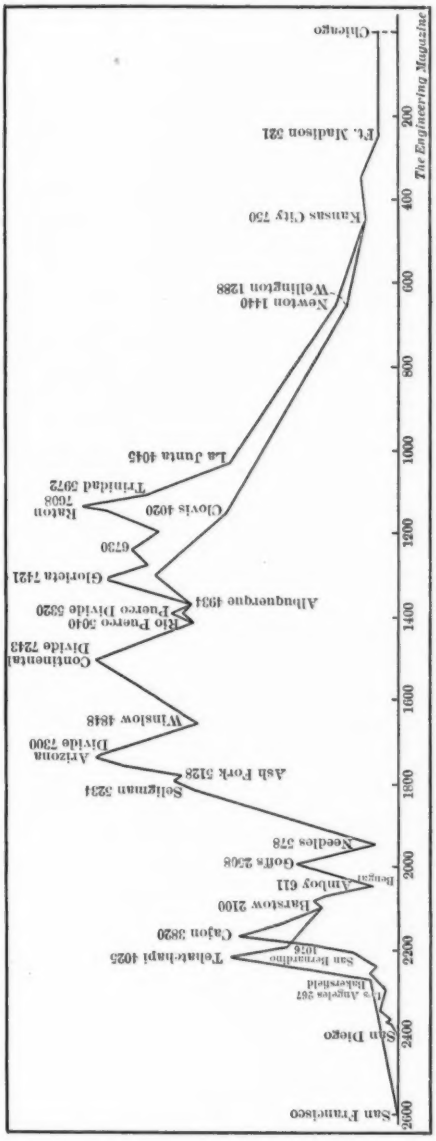
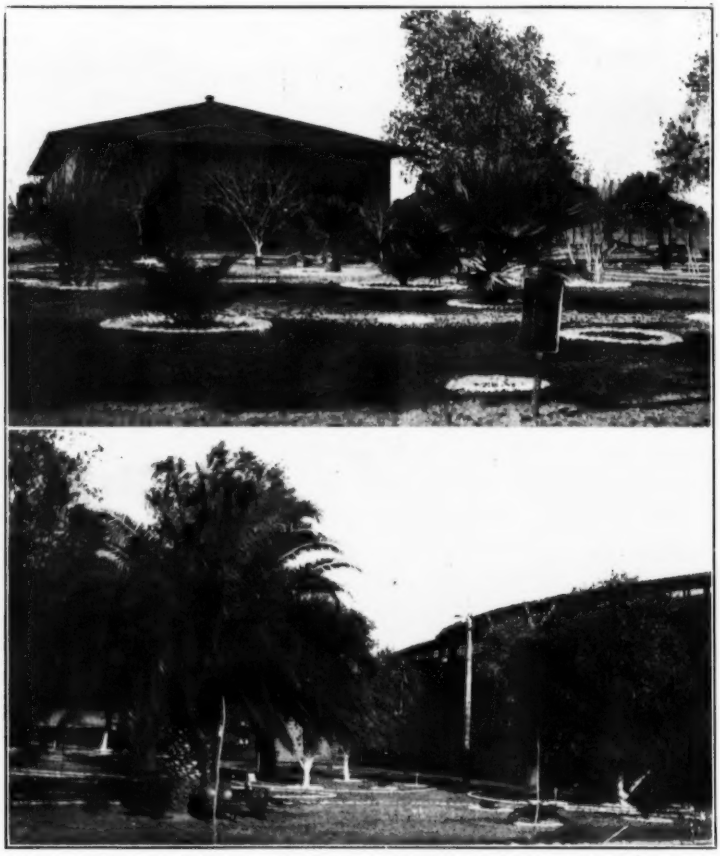


DIAGRAM OF PRINCIPAL SUMMITS AND ELEVATIONS ON SANTA FE TRANSCONTINENTAL LINES.

The new low-grade freight route across the Rockies referred to on page 917 is shown by the lower line from Rio Puerco to Kansas City. Horizontal scale, 1 in. = 400 miles; vertical, 1 in. = 4,000 ft.

In the nearly three thousand miles between Chicago and the Pacific Coast terminals (including both San Francisco and San Diego) the old main line crosses six great mountain ranges — Raton, (7,608 feet) Glorieta, (7,421 feet) the Continental Divide, (7,243 feet) San Francisco, (7,300 feet) San Bernardino, (3,820 feet) and Tehachapi, (4,025 feet). Even some of the smaller climbs would be marked as important on lesser roads, as, for instance, the 2100-foot rise in 31 miles from Needles, Cal., westward to Goffs; but these appear minor in comparison with the grades of 106 feet and 185 feet to the mile westward up the 16 miles of the Raton pass, and 175 feet



SHOP GROUNDS AT NEEDLES, CALIFORNIA, SHOWING MASTER MECHANIC'S OFFICE AND ROUND HOUSE.

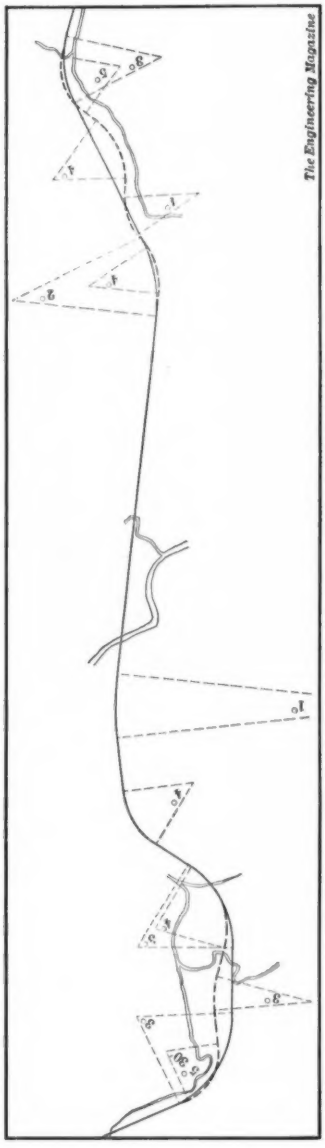
An example of environment improved for the comfort of employees. The grounds are made into a park for them and their families, and concerts are given by a band organized from among their number. The Japanese sign in the upper view says "Keep off the gross."

to the mile descending from the summit to Raton station; with 155 and 158-foot grades in the 9 miles from Glorieta to Lamy; with the 25 miles of 116-foot grade between Caliente and the Tehachapi summit, or the 25 miles of 2.2 and 3.0 per cent grade in the Cajon pass east of San Bernardino. For a thousand miles the railways runs through a treeless desert, incapable (at present certainly—much of it incapable ever) of affording local traffic sufficient to pay the section men.

Along a very large part of the whole line the water is bad, along much of it the quantity is scanty, and for considerable distances there is none. For a thousand miles, from Gallup westward, there is no coal. For some hundred miles, including the sites of necessary and important division points, the climate is unfriendly, living is difficult, and labor is hard to get and harder to retain. Of Needles, an experienced inhabitant said feelingly: "In summer there is only a thin crust between this place and hell—and the crust is badly scorched."

SAN BERNARDINO.

The conditions might well seem too hard to permit solution of the problems of constructing and operating the railroad to the coast—indeed, they might seem too hard, even if soluble, to justify the undertaking. But the great commercial reasons demanding the road, the conditions making its construction over all obstacles imperative, and the reward making its operation profitable—these appear when we have emerged from the Cajon pass or crossed the Tehachapi mountain. Along the northern branch lies the great Bakersfield oil region, the rich grape and fruit-growing country about Fresno, the fertile San Joaquin Valley, and San Francisco, with its trans-Pacific commerce and its Oriental freights. At the gateway of the southern branch is San Bernardino, with its rich mile upon mile of orange groves and olives, its commercial activity, and its expanding industries based upon the fruit culture; and from there to Los Angeles and beyond, the whole country is wealth-producing under the assured control of irrigation. Thirty-thousand carloads of citrus fruits were shipped



TYPICAL EXAMPLE OF RECONSTRUCTION WORK, MISSOURI DIVISION OF SANTA FE.
New track is shown solid, old by broken line. Total curvature in 8 miles (between Revere and Medil) reduced from 595 degrees to 485 degrees, and maximum curve from 5 degrees 30 minutes to 4 degrees.

from southern California last year, of which the Santa Fe handled 60 per cent—almost $5,500,000 gross revenue from this item alone. And irrigation is constantly increasing the volume of business to be handled. The Arrowhead Reservoir and Power project, which will gather flood waters from the upper reaches of the Mojave River and deliver them through 19 miles of tunnel across the dividing range into the San Bernardino Valley, alone contemplates a reservoir of 880 acres with a storage capacity of 61,000 acre feet; the two power drops of 1,500 and 1,865 feet respectively will develop 11,000 horse power, before the water is delivered for irrigation and domestic uses with a minimum flow of 2,000 inches continuously. This is but one of many undertakings gauging the expansion of the Coast region and its attendant traffic, and with it the heavy tourist travel is constantly growing heavier.

It is with this stream of passenger travel, with Oriental goods and fruit trains requiring special dispatch, with mining products, or further eastward with the live stock and the heavy crops of the

middle west and the central States, and with the heavy freight, merchandise, and machinery tributary to the population and pursuits of the region, that the transcontinental lines of the Santa Fe are occupied. The gulf division deals with timber, agricultural products and stock, and with the army of home-seekers pressing into the southwest.

Any review of railway betterment policies must begin with track, even though these papers are to be devoted particularly to the mechanical department and can include permanent way only in the broadest outline. Three important features are noticeable in the improvements under the Santa Fe engineering department: The construction of new low-grade lines and cut-offs, the rebuilding, double-tracking and revision of troublesome portions of the main line, and the unusual provision for economic maintenance of all track. The first two heads are those which are most closely interconnected with the maintenance of economy in the motive-power and mechanical departments; furthermore, they are so closely associated with each other that they can be more clearly understood if presented together than if considered separately.

The important reconstruction work begins on the Missouri division, which has been largely rebuilt from Fort Madison on the Mississippi to Kansas City, eliminating or reducing curves, lowering grades, and double-tracking the line for the entire distance. The heavy work on this is nearly complete, and much of the second track is in commission. Except for one short stretch of undulating country in Missouri, where a maximum gradient of 0.8 per cent remains, the result of the change will be to give a maximum grade of 0.6 per cent westward, from Chicago to the Missouri River. Beginning again at Newton on the main line, the division running southwestward via Wellington to Texico (which crosses the undulations of the land and formerly had a controlling grade of 1 per cent) has been improved and rebuilt, with a maximum grade now of but 0.6 per cent. From Texico to Albuquerque a wholly new line 270 miles long—the "Belen cut-off," constructed boldly to first-class standards throughout—rejoins the Santa Fe Coast Lines at Dalies and extends the 0.6 per cent grade westward to the Rio Grande River, while contemplated improvements of the main line beyond that will carry the same maximum gradient to Winslow. Thus the Santa Fe is at the point of securing its complete freight line from Chicago across to the Continental Divide substantially with no grade greater than 0.6 per cent. The heavy grades on the Raton, Glorieta and Continental summits alluded to above, and the long stretches of 1¼ per cent grade through Colorado and New Mexico,

STATION AT CLOVIS, N. M., ON THE BELEN CUT-OFF.
Showing the type of fireproof construction and the standards set in developing even a new country. Clovis is a division point on the new Santa Fe 0.6 per-cent-grade line for transcontinental heavy through freight. The saplings on the platform are to be planted in this new town.

are entirely eliminated, and this without increase of mileage. Indeed, the mileage from Newton to Rio Puerco over the Belen cut-off is slightly less than that by the old main line. Reference to the map and profile, on pages 912 and 913, will make the extent and effect of these changes clearer.

Further west, an extension from Parker (on the Colorado River between Arizona and California) to Bengal will give a low-grade line west of Ash Fork, cutting out the present grades of 1 per cent between Bengal and Goffs, 1½ per cent between Goffs and Needles, and a long 75 to 95-foot grade from Needles to Seligman. With the exception of about one hundred miles across the Arizona divide, and the unimportant stretch on the Missouri division already referred to, the Santa Fe has practically completed a first-class low-grade freight route from Chicago to the Sierra Madre Mountains in California. The line from Texico to Brownswood, referred to previously, will make this low-grade route complete also between California and the Gulf ports. The Arizona divide will still present about fifty miles of 75 to 95-foot grade against the traffic either way, and passenger trains will continue to use the old line; but a project is seriously con-

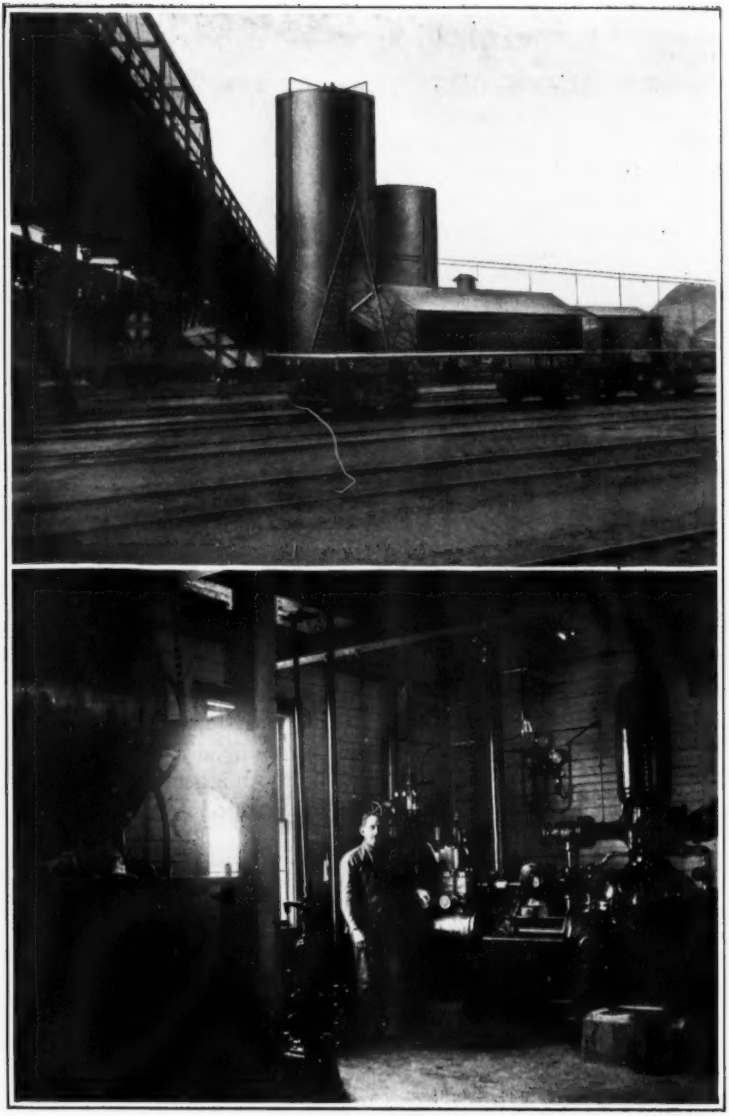
sidered for taking the trains over Raton summit (the hardest hill on the line) by electric power.

Improvement of line, reduction of grades, and even the use of electric power on mountain divisions, are of course in no wise peculiar to the Santa Fe. They are standard modern practice, though displayed here to an impressive extent. Standard also, of course, is the general excellent maintenance of track, though it is noteworthy that the Santa Fe policy has been to keep the line up to good condition through the past eighteen months, while many roads were curtailing expense on this account. In the tie and timber department, however, measures more peculiarly characteristic of the Santa Fe begin to appear. The Gulf lines of the system reach abundant timber, but the Coast Lines country is (or was) for the greater part treeless. The road has planted large stretches with eucalyptus from which, under proper foresting, it can supply an important fraction of its requirements for ties. The researches of the department have circled the globe, seeking woods suited for ties and structural work and for car and coach building. Lastly, and perhaps most important, preservative processes for ties and timber have been highly developed. The principal treating plants are at Somerville, Texas, with a capacity of about 16,000 ties a day, and at Albuquerque with a capacity of 4,000 to 6,000. For ties, crude oil is now largely employed (at least for all woods that will take it), as it has been found fully effective in protecting the fibre against decay for a term equal to the mechanical life of the ties. On woods that will not absorb crude oil sufficiently, and on structural timbers not subject to mechanical destruction, creosote is more generally employed.*

It is the policy of the road to use only treated ties and timber in new work, and in all replacements. Here again the work of the present secures the economy of the future.

The problems of water supply, so far as concerns quality, are solved by treatment with lime and soda, about one hundred treating stations being distributed over the system. The process is generally designed to operate with great simplicity under charge of the local

* The process of treatment is similar in either case, though the details are varied to suit the differing penetrative properties of oil and of creosote. The ties or timbers are loaded upon skeleton cars, and run into horizontal cylinders 120 feet long. The head is bolted on, heat is applied by steam coils, and the air is withdrawn. Crude oil or creosote is then pumped in and the tank is kept under a pressure of about 200 lb. and at a temperature of about 200 degrees F. (both approximately stated) until the gauge record of preservative pumped in shows a sufficient absorption per cubic foot of timber in the cylinder. This usually requires ten or twelve hours. The surplus oil or creosote is expelled by compressed air. The Albuquerque plant has two cylinders and the Somerville plant five. This latter, which uses creosote entirely, last year treated 3,250,000 ties, 9,500,000 feet, board measure, of lumber, and 600,000 lineal feet of piling.



WATER-TREATING AND STORAGE TANKS AND INTERIOR OF WATER-TREATING PLANT, LOS ANGELES, CAL.

The slacking tank and chemical tank are on the left, the small pump handling the lime water in the center, and the main water pumps on the right. A water motor on the discharge of these large pumps drives the other apparatus, the lime water being thus supplied practically automatically in proportion to the volume of raw water passing through the big pump. The whole apparatus and arrangement is of Santa Fe design.

pump man, checked by periodical inspections and frequent examinations by the chemical department. The reagent solution is mixed automatically in determined proportion with the raw water. Precipitation and sedimentation take place in the storage tank, the clear treated water flowing from the upper portion for engine use, and the deposited sediment being flushed at intervals through a valve at the bottom. The Santa Fe storage tanks extend to the ground, instead of being raised (as usual elsewhere) on a structural base with a specially supported tank floor. The lower 15 feet of the tank, at first glance apparently useless, actually serves as a settling basin, and in addition this form of construction effects a saving in expense of both material and erection. The operations and costs of the water-treating system, by divisions and in grand total, are shown in the accompanying table.

SUMMARY OF WATER TREATMENT, YEAR 1908.
Chief Chemist's Office, Topeka, Kansas.

SUMMARY BY DIVISIONS.	Grains Incrustants, Av'ge. Before Trtmt.	After Trtmt.	Removd.	Lb. Incrsts. Removed per M Gallons.	Total M Gallons Treated.	Total Cost, $.	Cost per M Gallons.	Total Lb. Incrsts. Removed.
Illinois	35.7	3.2	32.5	4.64	189376	4996.76	.0263	858402
Missouri	28.6	3.8	24.8	3.54	165613	3967.22	.0239	574380
Kansas City	24.2	3.7	20.5	2.92	152805	4158.87	.0272	446190
Eastern	26.3	4.1	22.2	3.17	300484	6741.55	.0224	931810
Middle	44.7	4.1	40.6	5.80	123749	6093.69	.0491	715724
Oklahoma	35.7	4.5	31.2	4.45	138591	3518.52	.0253	637750
Pan Handle	45.8	4.2	41.6	5.94	75274	3693.24	.0489	397448
Pecos V. Lines	39.3	5.5	33.8	4.97	28566	2011.13	.0704	131467
Western	34.4	3.9	30.5	4.35	163420	5770.13	.0353	681077
Arkansas River	60.2	4.5	55.7	7.95	229257	12850.54	.0560	1950419
Colorado	45.5	3.9	41.6	5.94	123327	3458.70	.0280	483292
New Mexico	41.6	4.7	36.9	5.27	178487	4386.19	.0245	803739
Rio Grande	31.4	3.9	27.6	3.94	61550	2979.19	.0484	231438
Albuquerque	33.9	3.8	30.1	4.30	307534	11614.51	.0377	1013431
Arizona	28.1	3.5	24.6	3.50	192646	7389.35	.0383	694368
Los Angeles	23.2	1.8	21.4	3.05	140859	4455.28	.0316	444114
Valley	33.7	3.3	30.4	4.34	42874	1661.06	.0387	207510
Eastern Grand	28.9	3.8	25.1	3.58	808278	19864.40	.0245	2710732
Central Grand	39.1	4.2	34.9	4.98	501034	19075.58	.0373	2431999
Pecos V. Lines	39.3	5.5	33.8	4.97	28566	2011.13	.0704	131[illegible]
Western Grand	44.7	4.3	40.4	5.78	592621	23574.62	.0397	3468888
Coast Lines	30.5	3.2	27.3	3.90	683913	25029.50	.0365	2359723
A. T. & S. F. Prop.	37.2	4.2	33.0	4.71	1930499	64725.73	.0335	8743136
A. T. & S. F. System	35.8	3.9	31.9	4.55	2642978	91566.36	.0346	11102859
System, 1907	32.6	4.3	28.3	4.03	2466965	87414.44	.0355	9579772
System, 1906	35.0	4.1	30.9	4.41	1913398	69081.46	.0361	7906233

ANALYSES OF COALS USED ON THE A. T. & S. F. R. R., 1907.

Mine and Shaft.	Proximate. Water.	Proximate. Volatile.	Proximate. Fixed Carbon.	Ultimate. Ash.	Ultimate. Sulphur.	B.T.U.
Big Four Mining, Coal City, Ill.	14.88	35.21	45.00	4.91	2.25	11110
Acme Mining Co., Streator, Ill..	9.70	38.33	45.86	6.11	2.81	11988
Toluca Devlin Estate, No. 1....	11.22	36.80	45.90	6.08	2.59	12154
Toluca Devlin Estate, No. 2....	10.51	36.89	45.46	7.14	3.33	11865
Roanoke	12.33	36.13	44.58	6.96	3.39	11801
Central Coal & Coke Co., Richmond, Mo.	13.89	33.66	42.59	9.86	4.05	10406
Marceline, Mo., No. 1.....	12.08	38.77	41.80	7.35	4.44	11433
Marceline, Mo., No. 2.....	1199	37.59	41.88	8.54	4.18	11010
Cherokee and Pittsburg No. 5...	5.20	35.31	53.77	5.69	2.48	13212
Cherokee and Pittsburg No. 6...	3.52	35.31	49.44	11.73	5.75	12825
Cherokee and Pittsburg No. 8...	4.68	35.12	52.51	7.68	4.01	12849
Cherokee & Pittsburg No. 9...	3.25	37.26	50.74	8.75	4.76	12690
Wear Coal Company No. 17....	3.54	36.81	53.47	6.18	3.88	13022
Devlin Miller Company.....	3.55	37.18	51.65	7.62	4.35	13487
Central Coal & Coke Co. No. 17	2.20	36.18	55.75	5.87	2.34	13361
Central Coal & Coke Co. No. 31	1.73	33.10	49.92	15.25	3.89	12664
Pittsburg & Midway No. 5.....	1.50	34.25	52.78	11.47	4.59	12354
St. L. R. M. & P. Co. Van Houten Mine	1.61	36.84	52.58	8.97	0.79	13098
St. L. R. M. & Co. Brilliant Mine	1.60	37.25	50.83	10.32	0.78	12741
C. F. & I. Co. Starkville.....	1.57	31.67	54.22	12.54	0.69	12779
C. F. & I. Co. Katcina at Morley	1.35	32.66	54.73	11.26	0.83	12986
Victor Fuel Co. Delagua C. & S. E. Ry.....	2.07	36.51	52.87	8.55	0.57	12532
Victor Fuel Co., Hastings.....	1.70	35.04	53.20	10.06	0.67	13113
Weaver near Gallup.....	12.19	38.29	43.75	5.77	0.76	11214
Heaton near Gallup.....	9.71	41.85	42.92	5.52	0.90	11722
Otero near Gallup.....	8.41	40.05	40.78	10.76	0.91	11219
Clark 1 & 2 near Gallup.....	11.04	40.23	40.93	7.80	0.49	11198
Weaver mixed Pea 60% and Slack 40%	9.98	39.40	41.52	9.10	0.69	11036
Weaver Slack.....	10.35	36.98	38.52	14.15	1.64	10261
Weaver Pea.....	10.03	37.87	41.35	10.75	.50	10959

RESULTS FROM STORING COAL SEVEN MONTHS IN THE OPEN AIR AND UNDER WATER.

Mine and Shaft.	Per Cent. Loss in Actual Weight. in Open Air.	Per Cent. Loss in Actual Weight. under Water.	B.T.U. of Ash As Mined.	B.T.U. and Water Free. Stored in Open Air.	B.T.U. and Water Free. Stored Under Water.	Per Cent. Loss in B.T.U. Stored in Open Air.	Per Cent. Loss in B.T.U. Stored under Water.	Total Loss Per Cent. Stored in Open Air.	Total Loss Per Cent. Stored under Water.
Big Four Mining, Coal City, Ill.	...	5.92	13851	13577	13844	1.98	0.05	1.98	5.97
Acme Mining Co., Streator, Ill..	...	2.12	14237	13877	13993	2.53	1.78	2.53	5.00
Toluca Devlin Estate, No. 1....	...	1.53	14696	13711	14151	6.73	3.71	6.73	5.24
Toluca Devlin Estate, No. 2....	...	2.80	14412	14001	13701	2.85	4.93	2.85	7.73
Roanoke	.95	3.18	14621	13385	13956	8.15	4.34	9.40	7.52
Central Coal & Coke Co., Richmond, Mo.	...	1.64	13647	13167	13686	3.52	...	3.52	1.64
Marceline, Mo., No. 1.....	...	...	14190	13664	13562	3.71	4.38	3.71	4.38
Marceline, Mo., No. 2.....	...	0.52	13856	13504	13890	2.55	0.04	2.55	.56
Cherokee and Pittsburg No. 5...	4.29	4.36	14831	14358	14269	3.16	3.78	7.48	8.14
Cherokee and Pittsburg No. 6...	...	...	15131	14543	14672	3.89	3.05	3.89	3.05
Cherokee and Pittsburg No. 8...	.60	...	14668	14237	14043	2.94	4.26	5.54	4.26
Cherokee & Pittsburg No. 9...	...	...	14420	14261	14130	1.10	2.01	1.10	2.01
Wear Coal Company No. 17....	.90	3.85	14422	14204	13170	1.51	8.68	2.41	12.53
Devlin Miller Company.....	4.40	5.18	15182	14562	14617	4.09	3.72	8.49	8.90
Central Coal & Coke Co. No. 17	...	...	.....	.....	.....	...	...	...	....
Central Coal & Coke Co. No. 31	...	...	.....	.....	.....	...	...	...	....
Pittsburg & Midway No. 5.....	...	...	.....	.....	.....	...	...	...	....
St. L. R. M. & P. Co. Van Houten Mine	2.58	1.60	14648	14465	14509	1.32	0.95	3.90	2.55
St. L. R. M. & Co. Brilliant Mine	4.73	5.53	14465	14260	14430	1.42	0.25	6.15	5.78
C. F. & I. Co. Starkville.....	1.41	3.04	14895	14691	14520	1.25	2.60	2.66	5.64
C. F. & I. Co. Katcina at Morley	4.18	1.43	14861	14689	14782	1.16	0.54	5.34	1.97
Victor Fuel Co. Delagua C. & S. E. Ry.....	...	3.31	14020	14345	14345	...	...	...	3.31
Victor Fuel Co., Hastings.....	4.78	0.26	14861	14292	14782	2.16	0.53	7.94	.79
Weaver near Gallup.....	2.69	0.48	13677	13384	13283	2.15	2.88	4.84	3.36
Heaton near Gallup.....	4.64	5.16	13818	13508	13320	2.66	3.59	7.29	8.75
Otero near Gallup.....	.64	3.83	13755	13107	13350	4.71	2.22	5.35	6.05
Clark 1 & 2 near Gallup.....	...	2.62	13789	13235	13714	4.02	0.55	4.02	3.17
Weaver mixed Pea 60% and Slack 40%	...	...	.....	.....	.....	..	...	...	....
Weaver Slack.....	...	...	.....	.....	.....	...	...	...	....
Weaver Pea.....	...	...	.....	.....	.....	...	...	...	....

TABLE SHOWING ANALYSES OF COALS USED ON THE SANTA FE AND RESULTS OF EXPERIMENTS ON WET AND DRY STORAGE.

These investigations by the Chemical Department of the Santa Fe show but little advantage in storage under water, and but little loss in weight or in heat units from storage through long hot summer months. Both results are unexpected and are very interesting. The value of the information is suggested by the fact that these analyses represent coal costing $3,000,000 a year.

Waterless sections of the road are supplied by tank trains from the nearest supply point, the longest hauls approximating seventy miles. Little towns or hamlets dependent upon local industries in these arid districts are supplied by the railway water trains at figures comparing favorably with ordinary municipal rates. In some cases pipe lines will replace the tank-car hauls, one such line projected from Willard eastward on the Belen cut-off having a proposed length of about one hundred miles.

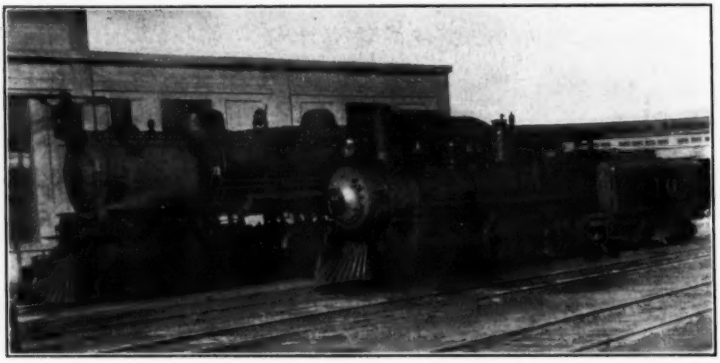
PART OF THE SAN BERNARDINO ROUND HOUSE, SHOWING TYPE OF REINFORCED-CONCRETE CONSTRUCTION, STANDARDS OF ORDER AND CLEANLINESS, AND STANDARD ARRANGEMENT OF PIPING.

Left-hand pipe is treated water, right-hand raw or washing water, center pipe steam. The lower connection on the mixer is for filling and washing purposes; the lower valve, in the box, is the blow-off line.

An interesting feature of Santa Fe practice, closely connected with water supply, is the heat-conserving system which appears in use at Raton, under construction at Needles, in partial service at other points, and is being made standard for the road. This method, in brief, uses the steam blown off from engines in the round house to heat the water supply from which outgoing engines are filled up again. This heat is preferably introduced in the treating tanks where it helps greatly in the precipitating reaction. The water blown off from the locomotive boilers passes into a sump tank, where it settles, and the clear or partly clear hot water above the sediment is pumped back

and used over again for washing out, thus not only saving a corresponding amount of fresh water, but avoiding the sudden cooling down which washing with cold water would occasion.

The fuel situation, so far as coals are concerned, is summarized in the accompanying table of analyses, to which is attached also the result of very interesting experiments on wet and dry storage, with determinations of loss in weight and in heating power under both conditions. West of Gallup, as already mentioned, there is no coal; the problem is abundantly solved by the use of oil-burning engines over practically the whole of the Coast Lines. The necessary arrangements of boilers, furnace, and firing have been brought to a high point of satisfaction; indeed, the delicacy and promptness with which one of the heavy oil-fired Santa Fe locomotives responds to her fireman's touch is remarkable. They can be forced to a very high rate of evaporation; indeed, they can be and are worked to a point that keeps two injectors going—but of course the wear of such service is hard, and the flue sheet suffers from the very high temperatures in the fire-box.



THE LARGEST AND THE SMALLEST LOCOMOTIVE ON THE LOS ANGELES DIVISION.

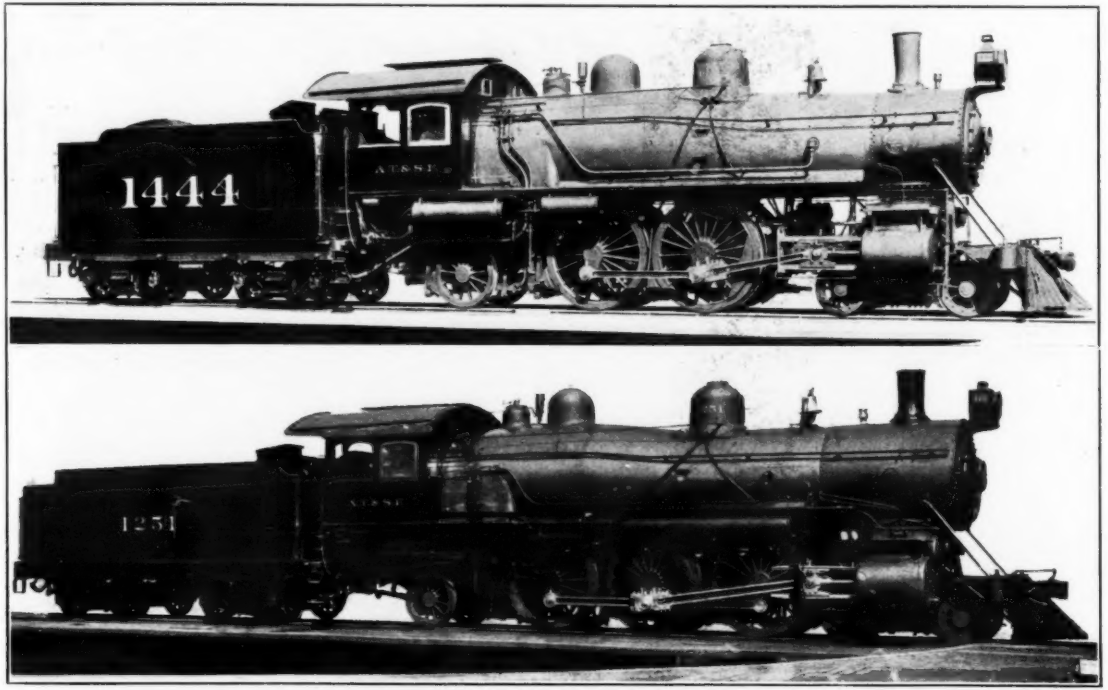
Suggesting the range of traffic conditions to be cared for. The smaller engine, of the "1" class (Manchester, 8-wheel) is an 18 by 24 with 1,366 sq. ft. heating surface and weighing 95,400 lb. The larger, of the "900" class (Santa Fe type) is a 19 & 32 by 32 oil-burning compound with 4,796 sq. ft. heating surface and weighing 287,240 lb.; both weights are exclusive of tender.

It is in the selection or development of motive power and equipment specially adapted to economical service under peculiar conditions, however, that the Santa Fe begins to show the strongest individuality and interest. Nowhere else in America has the compound locomotive been given so large place. About 700 out of some 2,000

MIKADO TYPE ENGINE USED IN MOUNTAIN SERVICE.

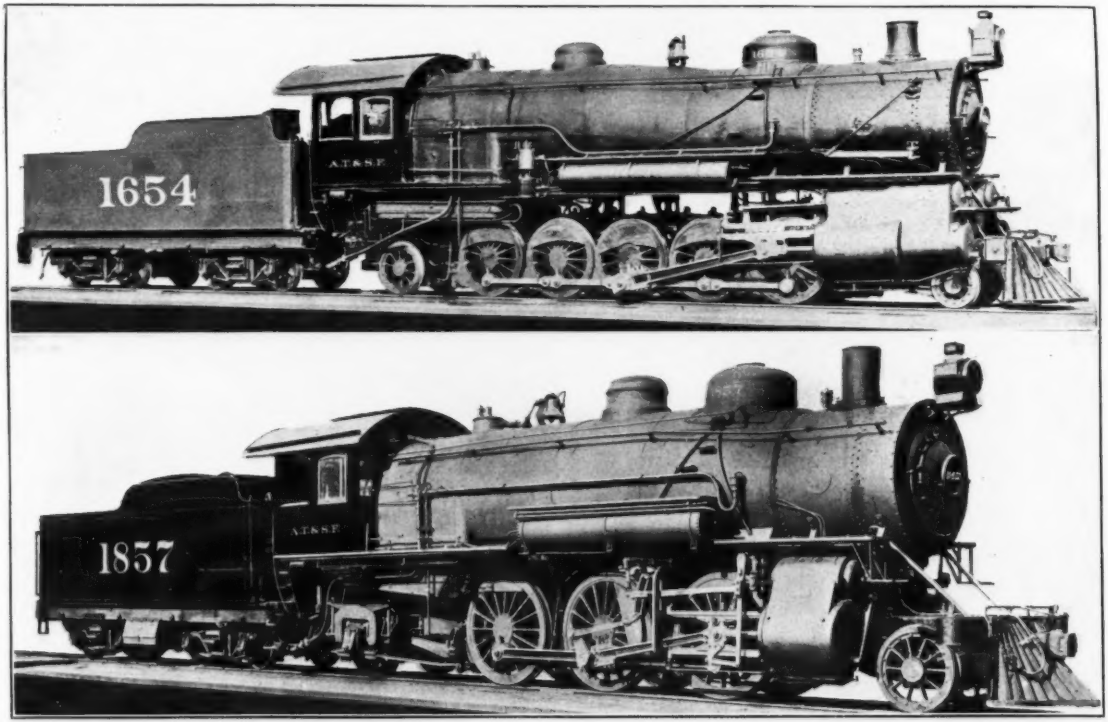
Equipped with new two-section firetube smokebox superheater, Jacobs design, and with testing box on front end. Engine weighs 261,720 lb.; cylinders 18 & 30 by 32 in.; heating surface 5,366 sq. ft.

engines owned by the road are of compound type. The proportion is very much larger than these figures would suggest, if we eliminate engines out of service or engines in yard and switching work and take only locomotives hauling trains on the road. The balanced compounds used in passenger service, based upon the most successful French express-locomotive types, have been developed to a point not reached elsewhere in the United States or in Europe for high speed with the least injury to track. Two freight types combining tractive effort with serviceability and good running speed have been evolved—one for level country and one for heavy grades. Superheating has been introduced to a greater extent than on any road in the country. Some of the heaviest engines in service in America are at work on the big grades of the Rockies, and heavier units still are under negotiation. The operating officials of the road have acted boldly and persistently on the conviction that compounding and superheat reduce the fuel and water difficulties by increasing the economy of fuel and water consumption—that the compound is not only a better machine, but all things considered a more economical machine. One feature which certainly is noticeable is the great starting power which is secured in these engines by simpling them for the first few revolu-



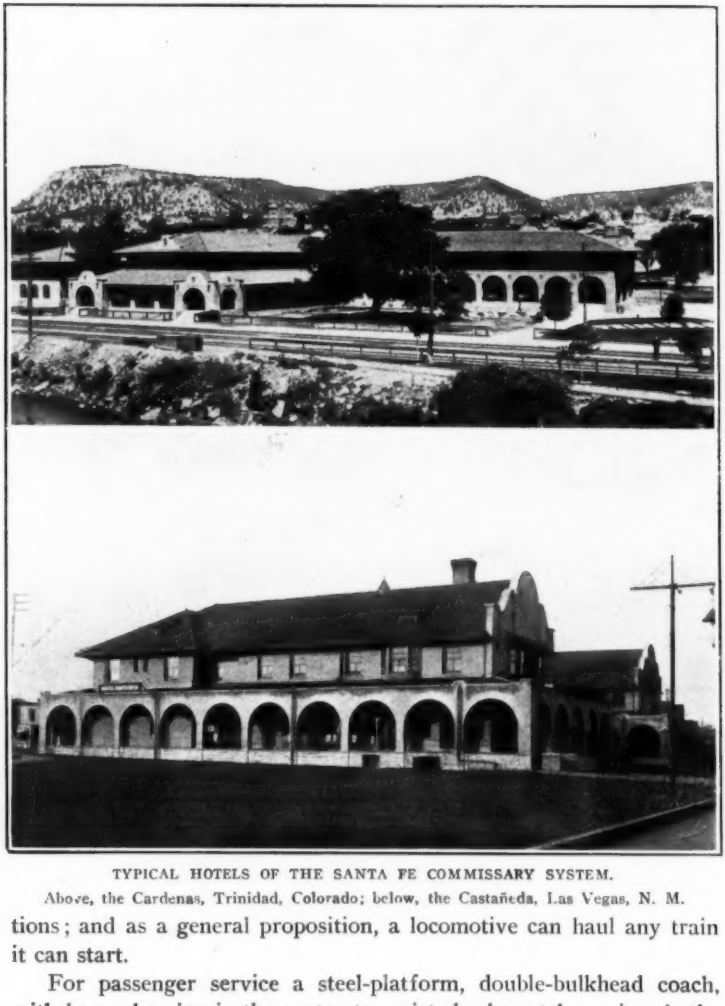
TYPICAL SANTA FE PASSENGER ENGINES. ATLANTIC TYPE ABOVE, PACIFIC TYPE BELOW.

Both are Baldwin balanced compounds. The Atlantic type is 15 & 25 by 26 in., 220-lb. pressure, 3,206 sq. ft. heating surface, and **weighs** 204,100 lb. with a tractive force of 22,200 lb.; 79-in. **wheels.** The Pacific type is 17 & 28 by 28 in., 220 lb., with 3,595 sq. ft. heating surface, and weighs 226,700 lb. with 151,900 lb. on drivers and a tractive force of 32,800 lb.: 73-in. wheels.



SANTA FE FREIGHT ENGINE TYPES.

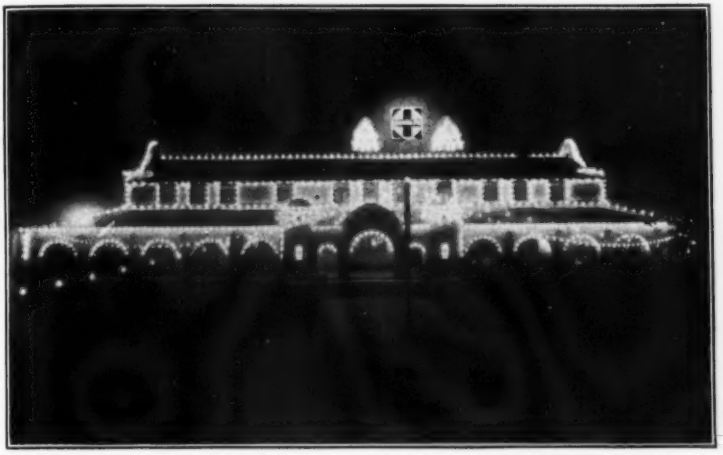
The "Santa Fe" type, above, for heavy mountain work, is a Baldwin tandem compound 19 & 32 by 32 in., 225-lb. pressure, 4,796 sq. ft. heating surface. It weighs 287,240 lb. with 234,580 lb. on drivers and a tractive force of 62,800 lb.; 57-in. wheels. The Baldwin "Prairie" balanced compound, below, is 18 & 30 by 28 in., 225-lb. pressure, 4,020 sq. ft. heating surface. It weighs 248,200 lb. with 174,700 lb. on drivers and a tractive force of 40,300 lb.; 69-in. wheels.



TYPICAL HOTELS OF THE SANTA FE COMMISSARY SYSTEM.
Above, the Cardenas, Trinidad, Colorado; below, the Castañeda, Las Vegas, N. M.

tions; and as a general proposition, a locomotive can haul any train it can start.

For passenger service a steel-platform, double-bulkhead coach, with heavy bracing in the center to resist shock or telescoping, is the standard. The framing, length, and general exterior design are the same as the standard Pullman sleepers, giving a symmetrical aspect to the train. For freight service the road has not favored extreme capacity cars, being convinced that statistics for the past few years show an inclination away from effective use of these extraordinary

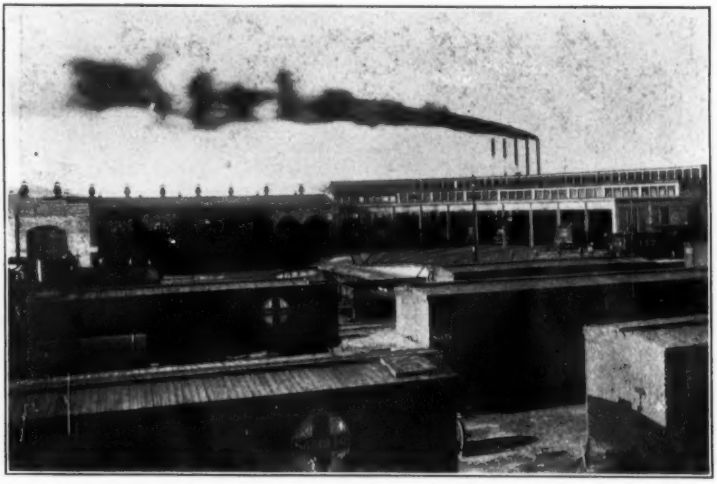


HOTEL ALVARADO, ALBUQUERQUE, ILLUMINATED FOR THE IRRIGATION CONGRESS.

units, and that investment in them is disproportionate to the average service secured. The Santa Fe adheres to a type which in practice gives the maximum proportion of actual load to marked capacity. A considerable portion of the traffic on the transcontinental lines is carried in refrigerator cars, and a large pre-cooling plant is to be erected at San Bernardino for increasing the economy and efficiency of this service in accordance with the latest ideas.

Lastly, a commissary department sufficient to reach across the thousand miles of desert takes the form of a remarkable chain of hotels under management closely affiliated with the road. These establishments impress the chance traveler by their superior and evenly sustained service. Centralized management, and intimate connection with the transportation facilities of the road, bring the advantages of high purchasing ability in the best markets, east or west, to the operation of even the smallest of the stations. Except for the limited trains (which carry diners) the fixed restaurant is relied upon because it serves a wider purpose than the dining car. It caters to the railroad employee, the commercial or transient visitor, and the local resident, as well as to the through passenger; and the standards set sensibly raise the level of the towns in which they are placed. Indirectly and directly through their personnel they are home-makers, and home-making is a really important economic factor in the upbuilding of much of the region through which the road runs.

This summary of the salient features of the Santa Fe road and its



THE ROUND HOUSE, RICHMOND, CALIFORNIA. POWER HOUSE IN THE REAR.
The left-hand portion of the round house is the original structure. The right-hand part, built since the earthquake, shows the modern Santa Fe methods in contrast with the old.

operation, necessarily brief, is intentionally made broader than the scope of the articles which will follow. Each feature touched upon is in its way an expression of a single and definite policy. Each has its proportion of influence in a certain result. This result is the attainment of determined standards and of assured profit in the manufacture of transportation on an immense scale, across unoccupied and unproductive country, and amid forbidding difficulties. Each of the institutions mentioned is the deliberate expression of a conscious purpose of the management of the road, and each must be noted to get any fully rounded image of the whole achievement.

The following articles will take up in closer detail the distinctively manufacturing features of the system in a stricter sense—that is, the stores department, shop methods, and bonus work; and a concluding paper will outline the relations with personnel as exhibited in the apprentice system and the welfare institutions.

THE ENGINEERING QUESTION IN THE UNITED STATES NAVY.

It requires perhaps an enthusiastic—even a boisterous—optimism to expect efficiency in the political administration of Government works. Any corporation one-quarter, or one-tenth, the size of the United States Navy Department that changed its head management as often as the Department has changed Secretaries during the expiring Administration, and that selected executives of the experience and training of most of these Secretaries, would make itself a by-word in the Street and a subject for a receivership. Most of these things we accept, because it is the Government way of doing things—the established order. But now that the politicians have assumed the rôle of efficiency organizers and are trying to adopt the language and guise of business administration, it is appropriate to look deeper and see who or what they are seeking to serve in this borrowed livery. Our contributor's accurate and intimate knowledge of the subject is evident. For obvious reasons, his name must not be given.—THE EDITORS.

FOR ten or twelve years, the status of engineering in the United States Navy has been such as to cause the greatest concern to those who are interested in the maintenance of that high standard which has characterized the design and construction of the machinery of our ships, as well as to those who believe that to maintain such a standard requires the services of men skilled not only in the theory which is the foundation of all sound engineering, but also in the practical application of that theory. When, ten years ago, the engineers of the navy were amalgamated with the line, or military branch of that service, there was some misgiving on the part of engineers, both within and without the navy, that the experiment would prove a success; but the engineering profession was satisfied to accept the judgment of such men as Engineer-in-Chief Melville, that there was no question of the success of the scheme, if (and always there was that *if*) only the law were administered in the manner contemplated by its advocates and by the Naval Committee of Congress.

Unfortunately for the successful carrying out of the plan, the amalgamation was almost coincident with a large increase in the navy, demanding such an unexpected addition to the number of young officers for the performance of purely military duty as to leave few for training in engineering, and thus, from force of circumstances, the purpose of the framers of the law was for a time defeated.

Gradually this condition has been improving, until now the graduates of the Naval Academy are more than enough for the military duty, and are sufficient in number to permit the purpose of the amalgamation scheme to be carried out as its friends expected it would

be. So far has it been possible to do this during the past two years that in the battleship fleet which has just completed its cruise around the world, only three or four of the chief engineers are engineering graduates of the Naval Academy, the others being officers with a taste for engineering, who, by study and hard work, have developed into competent engineers, a fact which is attested by the self-supporting character of each ship during this unprecedented cruise.

Just as this happy condition was culminating, the Secretary of the Navy dealt a blow to engineering which is as difficult to explain as the necessity for it is incomprehensible, and which will do more to retard the development of engineering in the United States Navy than any single act since the beginning of the steam navy. By a recent order, he has subordinated the Bureau of Steam Engineering, whose work has always been of the highest order, by appointing the Chief Constructor as the acting chief of that bureau and thus humiliating that small but accomplished body of engineers in the navy who have been conspicuous for their devotion to duty and for the excellence of their work in design and construction, rather than for their attendance at balls and banquets, which seems to be just now a desideratum for official preferment.

Added to this is an order absolutely removing from the control of engineers—civil, electrical or mechanical—all work in navy yards, which they have hitherto supervised; and an announcement of his intention to abolish the bureaus of Yards and Docks, Equipment, and Steam Engineering, as soon as he can get the necessary Congressional authority for so doing. But before proceeding further, it may be well to show briefly the organization of the United States Navy Department and navy yards, and return to a consideration of the questions involved in these orders of a secretary who has been in office less than three months and whose tenure must of necessity end with the Roosevelt administration.

The organization of the Navy Department is indicated below:—

	Bureau of	Chief.
Secretary of the Navy.	Navigation	Line Officer.
	Yards and Docks	Civil Engineer.
	Equipment	Line Officer.
	Ordnance	Line Officer.
	Construction and Repair	Naval Constructor.
	Steam Engineering	Engineer Officer.
	Supplies and Accounts	Pay Officer.
	Medicine and Surgery	Medical Officer.

The Bureau of Navigation is charged with all matters relating to officers and enlisted men and movements of ships; the Bureau of Yards and Docks with public works: that is, with the construction and

maintenance of buildings, docks, sewers and streets, and also has direction of central power plants; the Bureau of Supplies and Accounts corresponds with the purchasing department of an industrial establishment, with the additional duty of providing food and clothing for the men, and of disbursing the money appropriated for the pay of officers and men; the Bureau of Medicine and Surgery, as its name implies, has charge of matters pertaining to hygiene and health.

The four remaining bureaus—Equipment, Ordnance, Construction & Repair, and Steam Engineering—are the ones responsible for the construction and equipment of the ships, and for their maintenance in a state of preparedness for war. The Bureau of Equipment has the control of the electrical plant and of the ships' lighting and wireless telegraphy, provides anchors, chains, cordage, navigating instruments, and generally everything of a purely nautical character; the Bureau of Ordance has the armor, the guns and the ammunition; the Bureau of Construction & Repair designs the hulls and designates the spaces to be allotted for various purposes, such as magazines, boilers, and engines, provides small boats, anchor-hoisting and steering engines and winches; the Bureau of Steam Engineering designs the propelling machinery and its numerous auxiliaries, the boilers, and all piping necessary for making the machinery complete, does the heating and refrigerating, and has control of the fresh-water supply.

All questions arising in the naval service and in the Navy Department are referred to the bureau concerned for consideration and report to the Secretary of the Navy, who may or may not accept the judgment of the bureau, and may direct action diametrically opposed to that recommended. There have been instances where a Secretary of the Navy—always a weak one—has taken advantage of his position and of the possession of that dangerous quality, known as "a little knowledge," and has nullified the action of a competent technical officer; but such instances are of rare occurrence, and it may be said that business runs along as harmoniously as could be expected in an establishment of such magnitude and with such diversified interests.

If there is one criticism that might be urged against the system it is that it subjects the navy to periodical changes, such as the one now under consideration, from the fact that there is no permanent head, or as it has often been expressed, that it is a military organization without military control. The force of this objection will be apparent when it is remembered that there have been no less than seven different secretaries during the present administration, and that the result has been much demoralization and some disorganization. Thus it becomes a question whether it would not be better to supple-

ment the present system by the appointment of an officer of high rank who would have a supervisory position over the four bureaus or divisions which have to do with the fighting efficiency of our ships, coordinating their duties in such a manner that they would be immune from the idiosyncrasies of a transient secretary of few ideas and little judgment.

But to return to the organization. At each navy yard there is (or was) an organization based upon the departmental one, with a line officer of high rank as commandant or general manager, having under him technical officers as heads of each of the separate divisions or departments, each supposed to be an expert in the particular division to which he is assigned. The scheme is indicated below, so far as the technical branches are concerned:—

	Department of.	Head.
The COMMANDANT or GENERAL MANAGER (A Line Officer of high rank).	Yards and Docks	A Civil Engineer.
	Equipment	A Line Officer expert in electrical engineering (Equipment Officer).
	Ordnance	A Line Officer expert in ordnance (Ordnance Officer).
	Construction and Repairs	A Naval Constructor (Construction Officer).
	Steam Engineering	A Line Officer borne for engineering duty only (Engineer Officer).

Orders for work emanate from the Navy Department at Washington, which may be likened to the central office of a large establishment, the Secretary of the Navy being the president of the company and the bureau chiefs the board of directors, each with his specialty. Each chief of bureau passes upon all requests for work in his specialty and the estimates of cost, and designates the amount that may be spent in any month. The orders for work are addressed to the commandant (general manager) and he distributes them in accordance with their nature to the head of the department to whom the matter pertains. The latter then directs the work in the shop, or on the ship, as the case may be, and is directly responsible to the commandant for its proper performance within a specified time. He is required to make weekly reports to the commandant, which are forwarded to the Navy Department, and in these reports to state the condition of work on each separate job, the degree of completion, and the additional time necessary for completion. Under this system any question relating to the buildings, the streets, the sewers, or the power plant of a navy yard would be referred to the civil engineer; matters relating to the dynamo engines, the wireless plant, or the anchors or chains of a ship, to the equipment officer; if the battery needs atten-

tion, the ordnance officer is the one consulted; if the structure of the ship is affected, the naval constructor; and if the engines or boilers, it is the engineer officer to whom the consideration of such questions is referred. This seems so logical an arrangement that one wonders why a change was thought of. But unfortunately—not for the organization, but for the administration of it—there resulted, as a growth of the system, the establishment in the navy yards of independent shops under each bureau, so that in some of them there would be two or three foundries, machine shops, pattern shops, and smitheries, which naturally were not conducive to economy of operation. To remedy this condition the Secretary of the Navy last year consolidated some of these independent shops, so that in each yard there is now one pattern shop, one foundry, one blacksmith shop, one carpenter shop and one paint shop, where before there were several. The foundry and pattern shops were placed in charge of the engineer officer, which would appear to be their natural place, and the blacksmith, carpenter and paint shops under the naval constructor. The machine shops still remained independent, and strong resistance was made by the naval constructor to putting them under the engineer officer, as was contemplated. The ultimate result of much discussion was the action of Secretary Newberry in placing all shop work, and all "public works" in navy yards, under the naval constructor, so that instead of the organization outlined above, the following is substituted:——

The COMMANDANT or GENERAL MANAGER (a Line Officer of high rank).	A Naval Constructor supposed to possess the qualifications of a civil engineer, an electrical engineer, an ordnance engineer, a naval architect and a marine engineer.

It may be that the navy possesses officers with such varied accomplishments, but hitherto such a prodigy of mechanical science has been supposed to be non-existent; and it is safe to say that if he did exist, such a genius would not have been permitted to remain so long in obscurity.

The remarkable order which, with a stroke of the pen, produces this transformation, is dated January 25, 1909, and states that the naval constructor will be "responsible for the efficiency of the manufacturing force"—that is, he will have charge of all shops and of the men employed therein—and that the heads of departments who have been displaced, the civil engineer, the equipment officer, the engineer officer and the ordnance officer—experts in their several lines—"may remain on duty" as inspectors, but without any responsibility for the work or authority over the workmen. In other words, the three officers of the sea-going branch shall have no voice in deciding matters for which their education and training qualify them in an especial

manner, and such matters must henceforth be decided by a naval constructor who, no matter how skillful he may be as a naval architect, cannot from the very nature of things be capable of rendering correct judgment. Were it not such a serious national question, involving, as it does, the fighting efficiency of our ships, the whole thing would be ludicrous. As it is, it smacks strongly of "Pinafore." Nay, more! It has resulted in actual deception at the New York navy yard, where the principal naval assistant to the engineer officer has been retained in a like capacity under the naval constructor (this by order of the commandant) and has the burden of the engineering work thrown upon his shoulders. Similar practice will undoubtedly be followed at other yards, the purpose apparently being to humiliate the engineer officers of the navy, to make them do the work as heretofore, but to give the credit for it to another class of officers.

At this point it is well to consider the remarks of Rear Admiral Barton, recently Engineer-in-Chief of the United States Navy, who in his last annual report thus comments on the necessity of combining the practical experience gained at sea with the application of that knowledge to the work of designing and constructing machinery. He says:—

> It is and always has been the opinion of this bureau that the greatest efficiency results when the officers who design our machinery are also the ones who superintend its construction on shore and later its operation at sea, for thus only can they acquire that familiarity with the needs of the service which suggests at once the things to avoid as well as those to adopt. I think it will be generally admitted by officers of the navy who have given close attention to the subject that the excellence of our ordnance, of our machinery and of our electrical equipment has been due to the fact that the officers who inspected the material and superintended the construction on shore were the same ones who afterwards at sea supervised the operation of these parts of the ships' equipment. And I believe that if this system is not fully carried out, there will be deficiency in that branch in which such a system is lacking.

With the removal of any control by the sea-going officers over the machines which are vital to the ship's efficiency as a fighting machine, we may expect to see American ships fall into such a state of inefficiency as that of the Spanish ships at Santiago or the Russians at Tsushima, for it can hardly be expected that officers will take a keen interest in making a success of appliances in whose construction they are denied a voice, but whose defects they are expected to remedy.

The question that naturally presents itself is "Was it necessary or expedient to make such a change?" That it was not necessary will be apparent to anyone who considers the engineering side of the question, and from that the question of expediency can be readily answered. For the past ten years the engineering situation in the navy

has been anything but satisfactory, as has already been stated, and the annual reports of the Chief of the Bureau of Steam Engineering have not failed to draw attention to that fact. From the time that the engineers of the navy were combined with the line officers, the education of all midshipmen at Annapolis has been the same, whereas before this amalgamation there had been a separate course for those who were to pursue engineering. Despite the lack of support for engineering during the past ten years, each year has witnessed the design and construction of ships of all classes whose machinery has challenged the admiration of engineers the world over, and while much credit is naturally due the builders, it is to the designers and officers charged with its operation that full meed of praise must be given.

When, in 1888, Admiral Melville was appointed Engineer-in-Chief in succession to the late Commodore Loring, he surrounded himself with a class of able young officers, graduates of the Naval Academy in engineering, and imbued them with much of that vigor and determination for which he is so noted. These officers soon became recognized in engineering circles as men of rare attainments, and with their increasing experience became more and more valuable to the Government. A few, allured by the offer of higher salaries than they could ever hope to receive in the United States Navy, resigned and are today amongst the foremost engineers in civil life. The majority remained in the navy and continued to do their share of sea duty, only to return after a three-years' cruise to take up again the work of design and construction of machinery, bringing to their work new thoughts and new ideas, born of daily contact with the machines whose design they had previously been so intimately associated with. These are the officers on whose shoulders the bulk of engineering work has fallen during the past ten years; these the officers who have continued the work of designing the machinery of our Fleet and who are now told that their training and experience of thirty or forty years count for naught, and who have been subjected to humiliation without a parallel in the history of the navy.

If the machinery of our ships had been a failure, if weakness had been shown, or machinery had failed to develop the power for which it was designed, some cause might be found for this action of the Navy Department. On the contrary, so well had that machinery been designed, and so careful had the designers been that it should not fail in an emergency, that the trials of our ships disclose the fact that many of our battleships and cruisers would have failed to make the contract speed had the engines not been so well designed that it was possible to force them in some cases as much as 30 per cent beyond

their rating in order to get the desired speed. Up to the establishment of the model tank at Washington, our ships had been powered by the engineers, but with the introduction of the tank and the towing of models this was changed, and the constructors specified the horse power necessary for a given speed. On more than one occasion, the engineers protested that the power was too low, and that their judgment was correct will be evident from the following examples:—

The armored cruisers California, South Dakota, Maryland, West Virginia, Colorado and Pennsylvania, of 13,680 tons displacement, were designed for a speed of 22 knots on 23,000 horse power. The average speed of the six was 22.28 knots, but it took 27,928, instead of 23,000, horse power to get it, and fortunately for the contractors the machinery was able to stand the forcing. The British armored cruiser Drake of 14,100-tons displacement, made a speed of 24.11 knots with 31,450 horse power, which power would not have driven our ships more than 23 knots. The three British cruisers of the Black Prince class are of practically the same displacement as our Maryland class, and yet with about 4,200 horse power *less*, they made about .7 knot greater speed.

Again, our three cruisers of the Charleston class, the Charleston, Milwaukee and St. Louis, of 9,700-tons displacement, were designed to make 22 knots on 21,000 horse power. Their average speed was 22.13 knots with 26,210 horse power, while the British cruisers of the County class, of 9,800 tons displacement, made 23.67 knots on 22,580 horse power. Further comment would seem to be superfluous, but as we had already built the Brooklyn, a cruiser of almost the same size and speed, it would appear to have been quite a simple matter to design these ships and come somewhere near the power required for the same speed as the Brooklyn: or, to put it properly, it should have been an easy matter to design as good a model as the Brooklyn's. The results of the design of these two classes of ships as compared with the similar ships of the British Navy are given below:—

	Displacement.	Speed.	I. H. P.
U. S. Maryland class	13,680 tons	22.28	27,928
British Drake	14,100 "	24.11	31,450
British Black Prince class	13,550 "	22.94	23,755
U. S. Charleston class	9,700 "	22.13	26,210
British County class	9,800 "	23.67	22,580

Other examples might be cited, but these are considered sufficient to demonstrate the fact that our naval constructors have a fine field for the exercise of their talent in trying to improve the design of the hulls of our ships, so that they may not suffer by comparison with foreign ships, and that it may not be necessary to force the machinery unduly in order to obtain the speed for which they are designed.

As if the humiliation visited upon the engineers of the Navy were not sufficient, the Secretary of the Navy announced in a memorandum, issued at the time of the order referred to, his purpose to abolish the Bureau of Steam Engineering altogether. Happily, this requires Congressional authorization, and it may reasonably be expected that Congress will think twice before committing such an act.

There is a question so closely related to this subordination of engineers in the navy, and of such vital importance to the Nation, that it must engage the attention of Congress and of the successor of the present secretary, and that is the supply of engineers. Under existing law, engineering is a prerogative of the line of the navy. Such duty is performed by line officers assigned to that special duty by the Navy Department, and it is manifestly necessary that these officers should have an opportunity to become familiar with shop work and with the various branches of the profession of engineering if they ever hope to become competent designers of machinery, as are the present engineer officers. It goes without saying that, when they see the humiliation to which they will be subjected if they take up engineering, they will avoid it as they would the plague, and the result to the efficiency of our ships may be imagined. It is idle to suppose that a young officer of any ability whatever would deliberately put himself in a position where his talents would never be recognized, and where he could never hope for that professional advancement which is the aim of every officer of a military organization, as it is of those engaged in civil pursuits. When young officers are told that if they enter the engineering field they will be forever barred from holding a position of responsibility, it may well be inferred that engineering in the navy will become the most inefficient branch of that service and our ships little better than lame ducks.

To find a cause for this remarkable action on the part of a retiring Cabinet officer would be most difficult. Some have attributed it to certain influences that have surrounded him and smoothed out rough places for him, others to a desire to create such a situation in the navy as would force the in-coming President to retain him in his Cabinet, while still others attribute it to pique that his ambition to continue as Secretary of the Navy had not received the support of line officers of the navy. Be this as it may, the situation is a deplorable one, and it is to be hoped that President Taft, with that rare good judgment which has always characterized his public acts, will give this matter his serious consideration and put engineering in the United States Navy on that high plane which its importance justifies and the efficiency of our Fleet demands.

A SIMPLE COST SYSTEM FOR COMPLEX SITUATIONS.

By John Sturgess.

IF apology is required for describing another special cost system. the excuse must be that the system briefly described here has proven satisfactory after the more recognized systems had failed, and the belief that the reasons why they failed apply with equal force to many factories, even when methods and administration differ widely from those obtaining in the particular institution under consideration.

It should be stated that only one class of factory is kept in view in this article, namely, that manufacturing more or less elaborate standard machinery or apparatus, of a number of types and sizes, where many of the individual parts are common to more than one size or type. It is thought that the above covers a somewhat large class.

The systems which failed (or at least, did not give such satisfaction as the system here described) may be briefly summarized as follows:

Group Costs.—In which a number of machines of given type and size were put through the shop together, on one shop order, time being kept by the men engaged on such shop order by time books or shop-order cards, either entered by hand or punched by recording clock, these cards being turned in daily or weekly, or at the termination of the job according to circumstances, and entered in the cost-ledger account representing that particular shop-order.

Operation Cost.—In which every operation in the construction of all machines manufactured was given a serial number, all such numbers being tabulated and indexed, a job-card bearing the number of the operation to be performed, and the number of pieces to be made, being given to each man, who recorded the time occupied by recording clock or otherwise.

Piece Cost.—In which a card was used to represent each piece of every machine, all operations entering into that piece being marked on the card, and the time occupied being punched or entered in the

margin, the time being recorded either for individual operations on the piece, or for all labor regardless of operation.

The above three methods are typical, though variations of each were tried. The book-keeping methods by which all records were brought together so as to give the final cost of any one machine need no comment, except to say they involved a large amount of work, an immense number of cards and entries, and a delay of from a few days to several weeks before any tangible total could be arrived at, which even then was not trustworthy.

Without particularizing, systems based on the above general lines failed for the following reasons:

a. They seriously interfered with the routine and order of manufacture found most economical from shop standpoints, and tended to delay shipments, and especially emergency orders.

b. Their accuracy depended on the veracity of the men, or foremen, recording their own time, which is not reliable, even with recording clocks. If costs advanced (as from bad castings, mistakes, etc.) no satisfactory and reliable explanation could be obtained after the necessary interval had elapsed for collecting totals.

c. Though simple in conception, they became cumbersome in practice, necessitating a vast amount of transferring of entries, and failed to co-ordinate matters properly, so that totals could be instantly grasped and compared, and so that any detail, from the total cost of the machine to the name of the man who drilled a certain hole in a certain piece, could be traced in a few seconds. The importance of this will be appreciated when it is borne in mind that the articles manufactured consisted of several hundred pieces, costing several hundred dollars, the individual items consisting of a great number of small amounts of, sometimes, only a few cents each.

d. They necessitated a vast amount of unnecessary repetition work.

The system described below was found to be free from all above defects and enabled accurate costs to be obtained at moderate expense. In order to appreciate its application, it is desirable to set forth the following data of the business to which the system was applied, and it may be remarked here that the first requisite, when adapting a cost system to a given business, is to have a perfectly clear conception of the essentials of the business, such as is covered by these data.

Classification of Articles Manufactured.—These comprise three classes of machines: (1), water-wheel governors; (2), relief valves; and (3), air compressors, and a variety of special accessories for each.

Each class is made in a number of different types, (A. B. C. etc.) and sizes (1, 2, 3 etc.) but a considerable number of the parts of each class are used on all the types and sizes, these being termed "standard parts." Some of these standard parts, however, have slight modifications, according to the type or size machine they are to be used upon. A standard part may consist of a single piece or a group of pieces. Thus, a centrifugal governor, consisting of 36 pieces, is standard for all types and sizes of Class 1 (water-wheel governors), this being also the case with a lever consisting of one piece.

Pieces which are not included in the above classification of standard parts are standard for one or more types or one or more sizes. Thus, the same cylinder may be used on a *single size* of a *number of types*, while a pedestal may be used on a *number of sizes* of a *single type*. Some pieces are special for a single size of a single type.

For the purpose of facilitating manufacture, minimising stocks on hand and reducing the number of patterns and drawings, the above method of standardization is carried to the utmost extreme consistent with meeting market requirements.

System of Manufacture.—All labor is on the day-work plan, quantities not permitting piece work. All material, including castings, is purchased outside.

Standard parts are made up in quantities according to prospective requirements, usually one or more dozen at a time. Parts which are standard to a limited number of sizes or types are made in less quantities, and parts which are special to a single type or size are usually made only after orders for the machine have been received. In order to reduce costs, parts are made in as large quantities as are consistent with possible changes in market requirements, improvements in design, or methods of manufacture.

A somewhat important factor affecting the accuracy of costs is that it is not always advisable to finish one class of operation completely on a number of pieces at one time. Thus the lathe work on fifty valves may be performed by the whole lot being rough-turned by one man at one time, another man finishing these in smaller quantities at different times as required. The method of dealing with this is described below under "suspense operations."

Orders.—The great majority of orders are contracts covering

one or more machines, and frequently include special apparatus for connecting the machines to adjacent machinery at their respective destinations. It often happens that the cost of this special apparatus can be considerably reduced by slight departure from standard dimensions in the terminal parts of the machines, in such cases a considerable advantage resulting when competing against others who may not possess such latitude, and are consequently compelled to submit higher bids. It is comparatively rare for a standard machine to be ordered without reference or consultation as to its fitness in every respect for its proposed destination. Consequently machines are rarely completely assembled and finished until they are assigned to specific contracts.

Cost-records Desired.—The necessity of adopting the classification and method of manufacture described above renders it impossible to keep the individual cost of each machine as a whole, during its progress through the shop. Its total cost must be found by adding the cost of its constituent parts (standard, semi-standard or special) and the cost of assembling.

It is not imperative to record the total cost of each individual machine made, if it is an exact duplicate of others whose cost is known. It is sufficient if the cost of individual parts or operations be recorded so as to note any variation in cost due to changes in the cost, or efficiency of labor or material. For this reason it is desirable that the detailed costs should be so tabulated that any variation in total cost of any part shall be quickly apparent, and simple references provided enabling the reason for the variation to be easily looked up.

THE COST SYSTEM.

Cost Keeper.—The whole of the cost keeping is performed by *one young man* who has had some experience in the drafting room and shop, and is therefore familiar with each part of each machine and knows exactly how and when it is used. *The foreman or men take no part in keeping records.*

Time Recording.—The cost keeper keeps record of the work each man is engaged upon by *personal observation*, making the round of the shop every half-hour for this purpose, using a special tally card to note any change in the occupation of any man since the previous round. As changes are not very frequent a short time only is consumed in making the round, a glance sufficing to show any change. If a change has occurred it is necessary to question the man or the foreman to ascertain the exact time of the change of job. This is

the only element of inaccuracy, but under the worst conditions it cannot exceed half an hour and is usually much closer, as no difficulty is found in getting straightforward answers. It is far more accurate than any system when the men put down, or punch on a clock, their own time. It also avoids the charging of time to one job which is really spent on another, or charging to the "shop" time spent in preparing tools etc. for a job which should bear the cost of such preparation. If extra time is consumed on a job on account of bad castings, lack of facilities, or other sources of wastefulness, the circumstances and amount of time are noted on the tally card and recorded on the cost card, but the total time is charged to the job. This makes a subject-of-record a fruitful source of discrepancy between "estimates" and actual results, and reduces the troubles from "excuses" and fictitious "explanations."

At the end of the day the time data collected on the tally card are entered on a "job cost card."

Job Cost Card.—These cards are 10½ by 8 inches (see Figure 1)

Cost Sheet, Sturgess Eng. Co.

DATE JOB (Name of part entered here) NO.

FOR (Name of Machine is entered here) MARK To correspond with Indexes.

Lathe Rate				Drill Rate				Planer Rate				Boring Mill Rate			
Man's Name	No. of Pcs.	WORK	Total Hours	Man's Name	No. of Pcs.	WORK	Total Hours	Man's Name	No. of Pcs.	WORK	Total	Man's Name	No. of Pcs.	WORK	Total Hours
Shaper Rate				Miller Rate				Boring Lathe Rate				Bench Rate			
Man's Name	No. of Pcs.	WORK	Total Hours	Man's Name	No. of Pcs.	WORK	Total Hours	Man's Name	No. of Pcs.	WORK	Total Hours	Man's Name	No. of Pcs.	WORK	Total Hours

FIG. I. JOB COST CARD FOR ENTERING THE TIME AS RECORDED ON THE "TALLY CARD." The back is ruled for "Material," and columns for summarising the total cost of material.

and are ruled with a series of triple columns headed "Man's name" "No. of pieces" "Work" and "Total hours." One series of columns is assigned to "Lathe," another to "Drill," and so on for all the operations entering into the construction of the piece. On the back of the cards are rulings for 'Iron" "Steel" "Bronze" and "Stores," with a space for summarising the total cost of material for the part, or parts, represented by the card. *Each card represents one piece of the machine* (or in some cases small groups of pieces), and there are therefore nearly as many cards as there are pieces in the machine. These cards are bound together to form a "book."

As there are some hundreds of pieces in some machines, these books would be inconveniently bulky were it not for the fact that a large number of the pieces compose the standard parts. Each group of standard parts, however, are dealt with as though they were a separate machine and a book made for them accordingly, the total cost of each standard group of parts being carried to the "Summary Book" as a single item. This reduces the number of cards in a book to about 40 for the most elaborate machine and avoids detailed repetition of the standard parts under each machine in the summary book.

Suspense Operations.—Certain operations cannot be carried through continuously for the reasons described under "System of Manufacture." Such operations are kept on a "Suspense Sheet" until a sufficient number have been completed to enable the total cost of such operations on a sufficient number of pieces to be found, before entry is made on a cost card.

Indexing Cost Cards.—As from 300 to 500 cards are in use a ready method of indexing is necessary. Each type, size, and class of machine is known by a denoting letter, while each piece of each machine is known by a number. Each book of cards is marked with the letter representing the machine dealt with, and is kept in an open-top file subdivided alphabetically in thumb-index fashion so that the letters on each are visible. Hanging above the file is an index (see Figure 2) giving the names of each machine and the denoting letters, so that one glance enables any book to be instantly located and withdrawn by one hand.

At the front of each book is another index (see Figure 3) giving the names and numbers of the individual pieces dealt with in the book. The cards are numbered in serial order, the number on the card corresponding to the number of the piece, so that after withdrawing the book a glance at the front (index) card enables the card

INDEX OF DENOTING LETTERS

	File.
No. 1 Self Contained Pump	A
No. 2 Independent	B
No. 1 Air Compressor	C
No. 2 " "	D
No. 3 " "	E
No. 6 " "	F
No. 1 and 2 type "K" Governor	G
No. 1 and 2 type "M" "	H
No. 3 type "M"	I
No. 4 " "	J
No. 5 " "	K
No. 1 and 2 type "L"	L
Centrifugal Governor	M
Dash-Pot Arrangement	N
Pilot Valve Chamber	O
Hand Lever Control	P
12" Auto. Oper. Relief Valve	Q
15" " " " "	R
20" Mech. " " "	S
24" " " " "	T
Poppet Valve Arrangement	U
By-Pass Valve	V
Motor Pump	W
No. 3 Independent Pump	X
Spec. type "C" Governor	Y
Auto. Pressure Regulator	Z

FIG. 2. EXAMPLE OF ALPHABETICAL INDEX OF ALL ARTICLES MANUFACTURED. This hangs above the alphabetically arranged file holding the cost cards. (See also Fig. 3.)

INDEX OF PART NUMBERS. FILE "D." NO. 2 AIR COMPRESSOR.

Card No.	
1	Sub base.
2	Lower half of casing.
3	Top half of casing.
4	Hand hole cover.
5	Bearing caps.
6	Upper half of inner bearing.
7	Lower half of inner bearing.
8	Cylinder.
9	Outer plunger.
10	Inner plunger.
11	Plunger cover.
12	Valve.
13	Filler for outer plunger.
14	Split ring for outer plunger.
15	Crank block.
16	Shaft.
17	Oil ring for shaft.
18	Throw ring on shaft.
19	Oil ring for bearing.
20	Sight feed oil cup.
21	Counter weights.

FIG. 3. EXAMPLE OF FILE D (SEE FIG. 1).

The cost-cards are clipped together in numerical rotation corresponding to the column at left. This form of index is affixed to the first card in each file.

corresponding to any desired piece to be instantly found. By this arrangement any card out of some hundreds or even thousands can be quickly located without memorizing a combination of letters and numbers and without the necessity of even putting down pen or pencil.

The elasticity of the card system is found desirable for the above-mentioned cards, but for summarizing the results in quickly compresensible form a multiple-column, cash ruled book is most convenient.

No. 2. AIR COMPRESSOR. FILE "D."

Corresponds with Index. No. of Part.	No. of Pieces.	Name of Piece.	Estimate.	Material.	Labor.
1	1	Sub. Base, Cast Iron.....			
2	1	Lower Casing, Cast Iron..			
3	1	Top Casing, " " ..			
4	2	Hand Covers, " " ..			
5	2	Bearing Caps, " " ..			
6	2	Upper Bearing, Bronze...			
7	2	Lower Bearing, " ...			
8	2	Cylinders, Cast Iron.....			
9					
10					
11					
12					
13					

FIG. 4. EXAMPLE OF RULING AND ENTRIES IN "SUMMARY BOOK."

One double page right across the ledger is given to each machine manufactured, successive labor records being entered in the multiple columns provided. The facing page is ruled entirely in columns for labor like the extreme right-hand column of this. The index of "Summary Book" is similar to Fig. 1, with the page number extended opposite each item of the index.

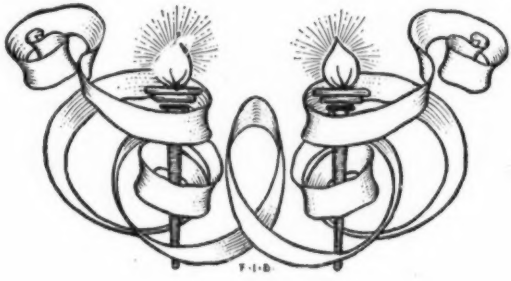
Summary Book.—This book contains reference and description columns at the left and a dozen or more cash ruled columns to the right. (See Figure 4.) In the reference columns are placed the denoting numbers of each piece and the number of such pieces used on the machine in question. The name of the piece is entered in the description column, one line right across the double page being devoted to each piece constituting part of a given machine. A double page is devoted to each type, class, or size machine manufactured.

In the first cash column is placed the estimated correct total cost of each part. In the second column is placed the cost of material only, taken from the accurate records on the cost cards. The remaining columns serve to record the labor cost as obtained by the cost cards at different periods, the respective columns being headed with the dates upon which the observations were made. This arrangement not only minimises the work of preparing the summary book

for successive records, but shows at a glance any variation that takes place in the cost of any part of any machine, the reason for which can readily be treated by means of the cost cards.

As nothing but the lump-sum cost of each part is given in the summary book, the usefulness of the record is not clouded by unessential figures or extensions. Moreover, as the cost of each individual part of the machine is given, the directions in which economies might be made are readily suggested, while the juxtaposition of the cost-items at different periods shows at a glance whether the costs are increasing or decreasing. These are vital considerations in any good system of cost keeping, for with many systems, after the records are completed at considerable expense the final results are so scattered and fogged by the inclusion of working data, and require so much "turning up," that a busy manager is more or less deterred from making the analysis out of which the real usefulness of cost records must come.

It is to be observed that the costs dealt with above are only the costs of material and labor, and do not include the indirect expenses or "fixed charges." Many methods for dealing with this item are in vogue, each no doubt having suitable application to different kinds of business; but for the character of business described in the foregoing by all means the most logical method is to ascertain the percentage of the aggregate of all the fixed charges to the wages paid to the productive workmen, and then to add to the direct cost of each machine an amount equal to this percentage of the labor item included in the direct cost. This will then give the total manufacturing cost, to which the desired profit must be added, this profit being real profit available as dividends and not consumed in meeting charges on the business, replacing equipment, refunding of capital, or allied financial adjustments.



CAMELS FEEDING NEAR THE RAILWAY IN TUNISIA.

Photograph taken from the train while in motion.

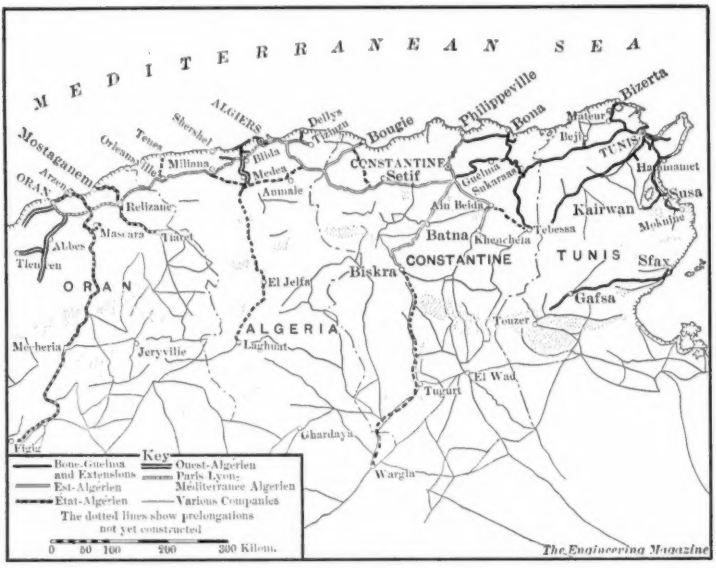
THE RAILWAYS OF FRENCH NORTH AFRICA.

By Edgar Allen Forbes.

This article is the result of personal journeys made in the interests of this Magazine by the author, who traveled from the southeastern terminus of the system at Kairouan, Tunisia, across the Moroccan border and then continued by sea to the southwestern border of French influence, at Mogador, Morocco.—THE EDITORS.

THE French railroad builders have received scant justice at the hands of those who make the periodical literature of the English language. Before coming to Africa, I went carefully over three recent magazine articles on railway progress in the Dark Continent and found only slight references to the lines in French colonies, the probable reason being that publicity is of great financial importance to those railroads whose stock is being offered to wary investors in London. It was something of a surprise to me, therefore, to find about 3,500 miles of good track in Algeria and Tunisia, with more than 200 trains a day on all the branches, counting in both directions.

Omitting from present consideration the only line in Morocco—which is just starting out from Casablanca—there are five companies at work in French territory, with a sixth operating a private line to its phosphate mines. Starting from the Moroccan boundary, the Paris-Lyon-Mediterranée Algérien company runs to Algiers; it also owns the short line from Philippeville to Constantine and has altogether about 500 kilometres of track. The continuation of the trunk



OUTLINE MAP OF THE FRENCH RAILWAYS IN NORTH AFRICA.

line from Algiers to Constantine (464 kilometres) is owned by the Est-Algérien company, which operates also the tourist line from Constantine to the Desert at Biskra and three other branches which bring its mileage up to about 1,000 kilometres. From Constantine to Tunis (about 450 kilometres) and from Tunis to the southern terminus at Kairouan (208 kilometres), the traveler is under the care of the Bone-Guelma company. It has a large number of branches, especially in the vicinity of Tunis, the total mileage reaching 1,500 kilometres. The phosphate company's unconnected line begins at Sfax, on the southeastern coast of Tunisia, and runs through the oasis of Gafsa to the mines at Metlaoui, a mining town of about 600 workers; this line is 243 kilometres long. A connection between Sfax and the trunk line at Sousse, 128 kilometres, is under consideration, but the gap is bridged at present by a public automobile in about six and one-half hours.

The lines of the other two companies run southward, at right angles to the trunk line. The Ouest-Algérien has three branches, the longest being that from Sainte-Barbe (southeast of Oran) to Tlemcen (152 kilometres); the other two have only 160 kilometres combined. The Etat road runs from Oran almost due south to Colomb-

Bechar, a distance of about 950 kilometres. Its only separate line extends from Mostaganem to Tiaret, not quite 200 kilometres.

The three divisons of the trunk line from Oran to Tunis, though owned and operated by different companies, have the British standard gauge of 4 feet 8½ inches, and may therefore be operated as a single line. Most of the branch roads are narrow-gauge and observe no uniformity even among themselves.

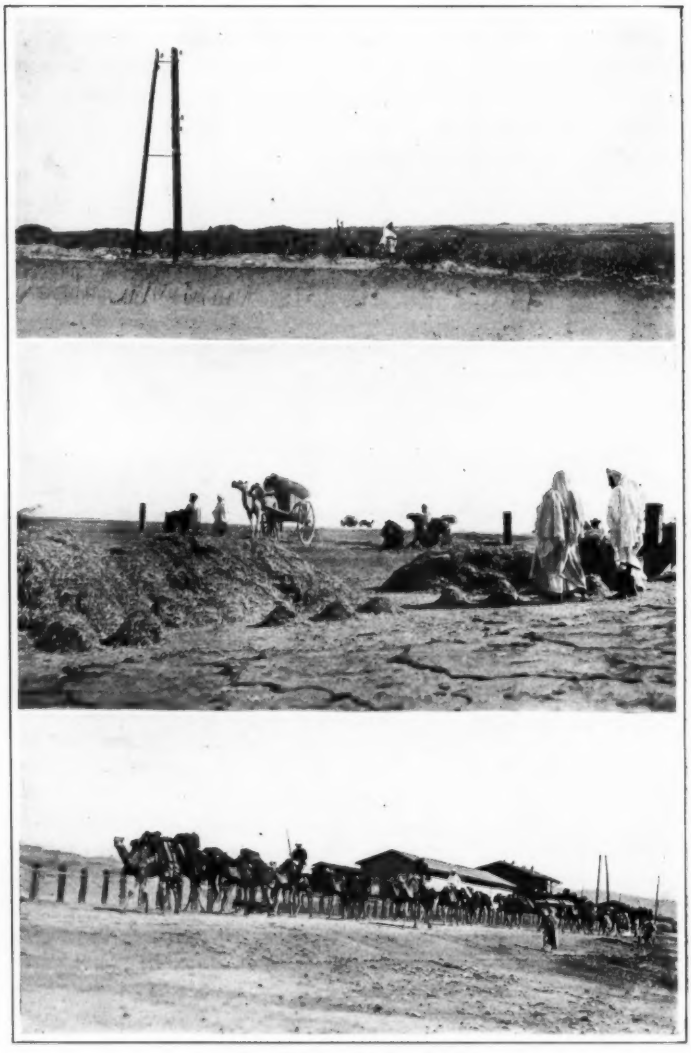
Principal Branches.	Kilometres.	Hours' Run.	Through Trains per Day.	No. of Daily Trains Over Parts of the Line.
Paris-Lyon-Mediterranée:				
Algiers to Oran	421	12	1	10*
Philippevile to Constantine	87	4½	4	..
Ouest-Algérien:				
Ste. Barbé to Tlemcen	152	..	..	7
Blida to Berrouaghia	84	6	5	..
Oran to Ain-Temouchent	76	2½	3	..
Etat-Algérien:				
Oran to Colomb-Bechar	750	26	..	3†
Mostaganem to Tiaret	197	9	3	..
Est-Algérien:				
Algiers to Constantine	464	14	1	10‡
Constantine to Biskra	240	10	1	1
Ouled-Rhamoun to Khenchela	147	9½	2	..
Bougie to Beni-Mançour	89	4½	3	..
Menerville to Tizi-Ouzou	53	4½	3	..
Bone-Guelma:				
Bone to Tunis	355	10½	1	12
Tunis to Sousse	150	6	2	2
Sousse to Kairouan	58	2½	2	..
Bone to Kroubs	203	7	2	2
Tunis to Kalaa-Djerda	235	10½	1	..
Souk-Ahras to Tebessa	128	6	3	..
Nine other branches	400	..	..	39
Cie. des Phosphates de Gafsa:				
Sfax to Metlaoui	243	9½	1	..
Casablanca (Morocco)	About 30	..	..	..

THE RAILROADS OF FRENCH NORTH AFRICA.

The hours' run is approximate and varies according to the class of train and the connections.

The future extensions of railroad building in this part of Africa will probably be, for the most part, governmental enterprises. A loan of about $3,000,000, negotiated in the early part of 1908, was mainly for the purpose of extending the Algerian lines. The small extensions north and south of the trunk line will be of only local importance, but three of the projects are pointed toward the Sahara Desert. The line from Biskra will doubtless be extended to the rich oasis of

* Also an express three times a week.
† Through train three times a week.
‡ Express three times a week.



ON THE EDGE OF THE DESERT.

The top view is a cactus farm near Kairouan, Tunisia—cactus being the food of the camel. Next is the "high-water mark" of transportation beyond the railroad. At the bottom is an engineering caravan starting from the station at Biskra into the desert.

CAMELS AT BISKRA, AFTER A SIX-MONTHS' JOURNEY FROM TIMBUCTOO.

Tougourt and Ouargla; the branch from Algiers to Berrouaghia may be carried as far southward as the oasis of Laghouat; and nobody knows where the state railway already in the Desert at Colomb-Bechar will finally stop. One dream of the French government sees through trains running from Oran all the way across the Sahara to Timbuctoo and Gao, on the Niger—connecting, perhaps, with the

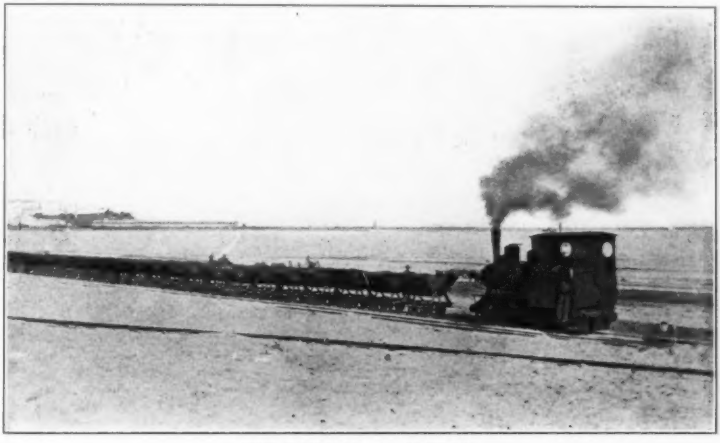
ENGINEERING OUTFIT PREPARING FOR THE DESERT.

British lines in Nigeria or with the proposed German road in the Cameroons, in the neighborhood of Lake Chad. But the amount of capital required to span the Sahara with steel would make any government pause; even a fast camel requires two or three months to cover the distance. Another dream, equally far short of realization, would connect this state road with a line to be constructed from the west coast of Morocco through the trading center of Tafilet, where the camel caravans from the south would be met by freight cars. But many things must happen in Morocco—and in Europe—before such a Moroccan line is even possible. The French are struggling desperately to retain their foothold on the ten-mile coastal area which the Algeciras conference allotted them, but the Moors want neither

GENERAL D'AMADE, COMMANDER-IN-CHIEF AT CASABLANCA.
Morocco's first railway is being built under his direction.

railroads nor Europeans and gladly avail themselves secretly of any intrigues that other European powers have jealously set in motion. Up to the French occupation of Casablanca, there was not a mile of railroad track in the whole land. The little toy track of Tangier, built for hauling dump carts loaded with sand for harbor construction does not count; the French have one like it at Casablanca, where extensive harbor improvements are well under way. The real railroad is a narrow-gauge line that has gotten about thirty kilometres from Casablanca. One newspaper reported it as being in operation, but I was told in December by General d'Amade, the commander-in-chief, that it had no locomotives and was at present used only for the transportation of military supplies, the cars being pushed by hand or hauled by mules.

Whatever one may say about the French as colonizers, they are thoroughly in earnest in the matter of transportation and communication. In Tunisia they have capacious harbors at Sfax, Sousse, Tunis, and Bizerte; Algeria has Bone, Philippeville, Algiers and Oran; and the only port in Morocco where the French are in full control is trying to make it possible for cargo and passengers to have a safe landing. (My own landing at Casablanca in December was made in a rowboat, against the positive advice of the captain of the small steamer anchored a mile from shore). The French flag is seen with great frequency in every one of these ports; the telegraph wires are everywhere, even beyond the termini of the railroads; and there is a camel postal-service entirely across the Sahara.



THE RAILWAY AT TANGIER.
The only track in Morocco, up to the French occupation. The outfit hauls sand for the harbor works.

The close connection between France and its north African possessions is shown by the schedule of its mail-steamers. The Cie-Générale Transatlantique boats leave Marseilles on Wednesday and Saturday evenings. Wednesday's steamer lands a passenger in Oran early on Friday morning, and he may be in Algiers Saturday morning; the other boat makes the same time. Special express trains on the Algerian railroads connect with the Marseilles steamers.

A glance at the map of Africa will show that only three little gaps now prevent a traveler from going all the way from Tangier to Cairo by rail. The first is from Tangier to the Morocco-Algerian frontier, a wild region where no kind of travel is now safe. From

that border one may ride across Algeria and Tunisia to Sousse where he meets the short gap that is bridged by automobile. The Sfax road will land him at Gafsa, from which point (or some other) a railroad is needed across Tripoli to the Egyptian frontier. There the Khedive's Mariout Railway will pick him up and take him to Alexandria, whence he may go to Cairo by the Egyptian State Railway.

THE ALGERIAN "DILIGENCE" FOR RAILWAY PASSENGERS AND FREIGHT.

Railroad finance is not a safe subject for a traveler to tamper with, but I should judge that the railroads of North Africa would have a precarious existence if they were not a governmental necessity. There are no forest products of great magnitude; phosphate of lime is the only mineral product that brings to the railroads any considerable revenue at present—and these deposits are not being exploited at many places. Agriculture is the main source from which dividends can possibly come, and to an American most of this vast country looks dubious. The colonist is relatively new to the land and his equipment is inadequate. He is not yet prepared to grapple vigorously with the all-important problem of irrigation. Unless a colonist enters North Africa with a capital of about $1,500, it is practically impossible for him to farm on his own account. Yet there are about 200,000 Europeans in Algeria alone whose living comes from the soil. Cereals, vineyards, olive orchards and cattle are the principal products, with dates from the oases; most of what is not consumed in the country

goes across to France. But the railroad catches the colonist "going and coming"; the farmer must import from France most of his necessities beyond what he himself produces.

In Tunisia, the colonist pays $4 or $5 an acre for his land, and the average French "domain" is 1,250 acres; that of other Europeans averages 250 acres. The large average of the Frenchman is probably due to the inclusion of vast estates like that at Enfidaville, which covers 300,000 acres and upon which have been found the ruins of seventeen Roman cities. This estate is owned by a French company which bought it from an ex-minister of the Bey. Some of the railway builders also have large estates. The company which built the phosphate line from Sfax received a concession at Gafsa of 100,000 acres, but it obligated itself to plant three-fourths of it in vines, olives, etc. The importance of some of the larger oases is shown in the case of Tozeur, an oasis situated about 80 kilometres south of Gafsa. It covers 2,500 acres, has a million palm-trees, yields annually about 60,000,000 pounds of dates, and brings in about $80,000 a year to the government in taxes.

A SUBURBAN ELECTRIC TRAIN NEAR TUNIS.

Turning from the subject of freights to the revenue derived from the individual passenger, even a traveler may speak with some confidence. To travel first-class on these lines costs more than in the United States, and you get less for the money. But this is Africa, remember. The trunk-line charges between Oran and Tunis amount to an average of 10 centimes a kilometre, or about 3 1-3 cents per mile; the second-class rate is about 2½ cents per mile, and the third-

THE CITY OF TUNIS.

class tickets are figured at about 1 5-6 cents. The comparative charges of the different lines on their longest runs are as follows:

Road.	Run.	Kilos.	Fare per Kilometre, in Centimes. 1st Class.	2d Class.	3d Class.
P.-L.-M.	Oran to Algiers	421	8.3	6.17	4.50
Est-Algérien	Algiers to Constantine	465	11.2	8.4	6.15
Bone-Guelma	Bone to Tunis	355	11.2	8.5	6.00
Ouest-Algérien	Ste. Barbe to Raselma	152	11.8	8.4	6.15
L'Etat	Oran to Colomb-Bechar	750	8.36	6.14	....
Phosphate Co.	Sfax to Gafsa	205	11.2	8.5	6.00
Average trunk-line	Oran to Tunis	1241	10.2	7.69	5.55
Average per mile in U. S. cents			3⅓c	2½c	1 5/6c

RAILROAD RATES IN NORTH AFRICA.

The P.-L.-M. rate for points between Oran and Algiers is higher than the through rate.

Stop-overs on one-way tickets are given subject to many conditions, but the holder of a 200-mile ticket may stop for 24 hours at only one point; a 300-mile ticket permits a stop of 48 hours. Round-trip tickets usually cost 30 per cent less than double the single-fare, but they also are subject to numerous restrictions. The limit is worked out mechanically as follows: One to 50 kilometres, 2 days; 51 to 100 kilometres, 3 days; 101 to 200 kilometres, 4 days; 201 to 300 kilometres, 5 days; 301 to 400 kilometres, 6 days; only the passenger with a ticket for 400 kilometres or more may stay a week.

Sundays and holidays are not counted, however. There is also provision whereby the limit may be extended one-half by the payment of 10 per cent additional. Children under the age of three are carried free, provided they are held on the knees; from three to seven years, they are charged half-fare but are allowed only half a seat; children of seven pay full fare.

The whole question of tickets in North Africa is extremely complicated. The man who wearies of the fad of stamp-collecting might find French-African tickets a good substitute, particularly if the specimens were surcharged according to the varying conditions. For example, there are the society and excursion tickets, sold at one fare for the round trip, but which are good only in groups of ten; they have a 10-day limit. Then there are seashore tickets sold only in the summer; they bring only half price. Watering-place tickets are different; they are sold all the year round and families of three get a reduction of 30 per cent; each additional member of the family comes in at 50 per cent. There is also a rate for farm-laborers, but they must travel by tens and in third-class compartments, unless a special car has been arranged; only one ticket is sold to the ten and the price is 4 centimes per kilometre. These laborers, by the way, are the only passengers treated generously in the matter of baggage; they may carry 600 pounds free, whereas the ordinary traveler must pay a high excess rate on everything above 60 pounds. On a small

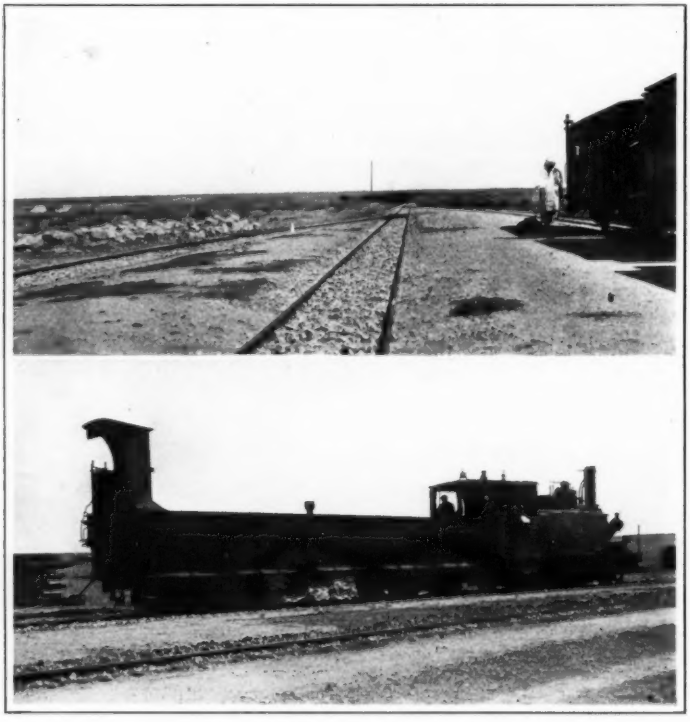
THE WHARVES AT ORAN, ALGERIA.

steamer trunk carried over these lines, I usually paid in excess charges from one-fifth to one-fourth the cost of a second-class ticket.

It struck me as rather strange to find commutation tickets on sale in Africa, for I had always associated them with a more advanced civilization. The photograph of the owner must be affixed, and the cost per kilometre varies in proportion to the distance. A 100-kilometre ticket costs as follows, in francs:

	Three months.	Six months.	Twelve months.
First class	311	467	700
Second class	234	351	525
Third class	171	157	385

There is also a class of college and lyceum tickets which are sold at one-half the commutation rates, but they apply only to qualified



ON THE BONE-GUELMA RAILWAY.

The upper view is a passing point between Sousse and Kairouan, showing the well ballasted roadbed and small rolling stock. Below is a locomotive and flat car, with covered seat for the brakeman.

DREDGING THE HARBOR OF ALGIERS.

The silt is delivered through the long pipe and deposited behind a dyke to form new ground for another pier.

persons between the ages of 21 and 26. These tickets permit no baggage to be carried free.

The nearest thing to interchangeable mileage tickets seems to be the *carte de circulation;* it is good on nearly every road in the system and entitles the holder to buy a ticket for half-fare at any time or anywhere. There are three classes of these *cartes de circulation*: with class A, the purchaser may buy first, second, or third-class tickets, at his pleasure; class B is good for second or third, at the holder's option; class C can be used only for third-class tickets. The cost of the *cartes* that would be such a boon to the American Travelers' Protective Association is as follows, in francs:

	3 months.	6 months.	12 months.
Class A	100	150	200
Class B	80	120	160
Class C	50	75	100

When sportsmen want a special train and can make up the required number of passengers, each must pay 10 per cent. above the first-class fare, and the revenue from baggage and dogs carried must not fall below a minimum of 6.15 francs per kilometre.

Relatively few sleeping-cars are seen along these lines, for most of the runs are short and even the tourist prefers to travel by day, less he miss something. As a rule, a sleeper costs 16 francs, regardless of distance, and a *place de luxe* costs 12 francs. Dining cars are

more common, but by no means common enough. They usually have three compartments and one waiter, except those running out of Algiers. The prices are about as follows: Lunch (including wine and "beefsteak") 3.00 francs; dinner, 3.50 francs; collation, 1.50 francs. There are several little tricks about these dining-cars that a stranger does not learn except by experience. For instance, if you chance to be in a crowded second-class compartment, you may go to the dining-car, order a simple lunch or a drink, and remain there in comfort so long as the car is attached. A favorite method of wise Algerians traveling from ten to fifty miles by a morning train is to go direct to the dining-car when the train is made up, order a cup of

NEAR THE HARBOR, ALGIERS.

coffee, and hold the seat until their destination is reached. These dining-cars as well as the sleepers are operated by the European Wagon-Lits company. Probably the occasional railroad restaurants are controlled by the railroads. The majority of the passengers on all the trains eat their own lunch in the compartments; the stray traveler is apt to go hungry for no trainman takes the trouble to tell him that this is the place where the train halts for refreshments. Likewise, the passenger who must change trains at a given point must depend upon himself; nobody notifies him.

Except for the turbans and flowing bournouses of the Arabs in the third-class (and occasionally in the second), there is but little about a North African train that differs from what one may see in Southern Europe. The locomotives come from France and bear about the same relation to an American locomotive as a burro does to a draught-

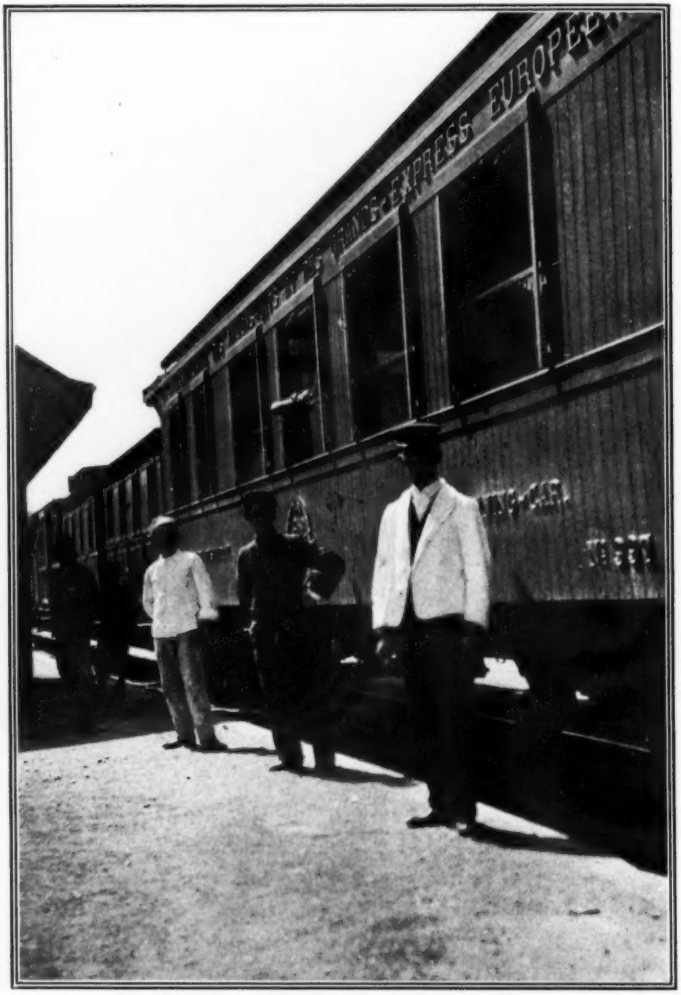
THE TELEGRAPH OFFICE AT SOUSSE.

The government operates posts and telegraph together.

horse. The coaches and cars are also European and have been gathered in from all sorts of bargain-counters. On most of the lines, they are merely rough boxes mounted on high wheels, with cheap seats or benches inside. The compartment system is universal, a

A TYPICAL STATION ON THE BONE-GUELMA.

The man in the foreground, with the little horn, is the station agent. The other Frenchman is the conductor.

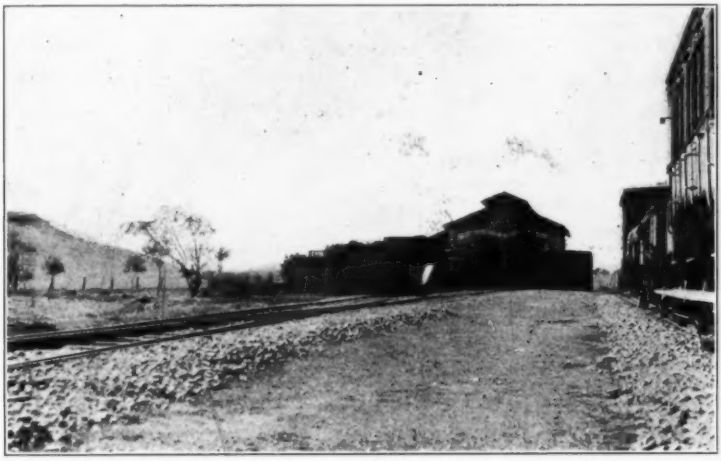


WAGONS-LITS DINING CAR ON THE ALGERIAN-TUNISIAN FRONTIER.

The cook, conductor and waiter are standing by the car.

coach generally being divided into four compartments into each of which ten persons may be squeezed. On the train from Tunis to the Algerian border, the coaches have little balconies on the side. Generally speaking there are three second-class compartments to one

first; and the number of thirds varies according to circumstances. On the branch lines mixed trains are the rule. There are no newsboys, no wash-rooms, and often no water-closets to be found. The compartments are dimly lighted by an oil-lamp in the roof, but reading is impossible when daylight vanishes. The freight-carriers are of slightly better grade, even on the narrow-gauge lines; and as one approaches Algiers from the east, many fine cars are to be seen. Throughout all of French North Africa, the railroad stations are substantial and attractive, with groves of eucalyptus trees affording the only shade for miles. The Arabs long ago robbed this land of practically all its forests, except in some mountainous regions.



AN EST-ALGÉRIEN ROUND HOUSE, WITH BRIQUETTES PILED OUTSIDE.

The crew of an ordinary train wear a light striped uniform that wholly lacks dignity. The ticket collector generally appears once somewhere along the line, and punches the ticket. It is not surrendered until the passenger reaches his destination, and there it is delivered to the station-agent on passing out the gate of the enclosure. Every station of importance has an Arab assistant to look after the natives, but the French trainmen are supposed to know enough Arabic for emergencies. The section-gang are usually Arabs, with Italian or Maltese foremen.

They have rather an amusing way of starting a train, especially in Tunisia. It is the station-master and not the conductor who gives the signal. He blows a shrill whistle, then the conductor blows a sort of bazoo, the engineer toots the locomotive, and we are off.

A JUNCTION POINT ON THE BONE-GUELMA.

The Chicago windmill in the background pumps water for the railroad tank.

At times the conductor calls out *"en voiture!"* before sounding his bazoo.

From an engineering standpoint, these North African lines do not, as a rule, greatly interest Americans. About two-thirds of the track runs through plains or follows valleys. In the Algerian Mountains, however, there has been done some fine engineering work of

many kinds. Two hours east of Algiers, the train runs through one tunnel after another, and there is at least one tunnel on the main line that is a mile in length. Apparently, it was cheaper to make tunnels than to build bridges, for I recall a long detour and four tunnels made in getting around a ravine. From a traveler's point of view, I should say that the road enters many of these tunnels at curves entirely too short; the locomotive is almost in some of them before the entrance can be seen.

AN UNUSUALLY FINE TANK ON THE EST-ALGÉRIEN RAILWAY, AT EL GUERRAH.

But these are the country's first railroads and we must not expect too much. As time passes by and the country reaches a higher stage of development, the lines will doubtless be straightened, the equipment improved, and the service bettered in general. Meanwhile, the railroads serve the country admirably, and the tourist generally finds something to growl at on any road.

SYSTEMATIC FOUNDRY OPERATION AND FOUNDRY COSTS.

C. E. Knoeppel.

VI. FOUNDRY ORGANIZATION AND MANAGEMENT.

Mr. Knoeppel's series began in our issue for October, 1908, and preceding parts have dealt with the elements of the problems of foundry costing, the importance of correct burden apportionment, and the classification and apportionment of costs.—THE EDITORS.

A FOUNDRY enterprise, considered as an organization, is in many respects like a chain, the strength of which is measured by its weakest link; and until the profit-eating elements—the inefficiencies—are discovered and eliminated, it cannot be expected to perform the *impossible* task of producing the results anticipated by its founders, any more than a chain can lift ten tons if one of the links, because of its weakness, is only strong enough to lift seven tons. To strengthen the links of a business—to make them work under a greater load—is the task which confronts every ambitious executive, and it cannot be done by concentrating attention on one link or a few links; *all links* must receive their proper consideration.

The demand of the times is *increased earnings;* this involves a search for latent earning capacity—a search in every nook and corner for opportunities to better results, whether good or bad; and this searching process should not be a haphazard, occasional, half-hearted affair, but a critical, systematized analysis all along the line. "Chemistry of results" is of vital importance, just as important to the success of the foundry as a business as "chemistry of iron" is to the melting operations as a single department of the business, for it considers the important fact that *productivity* is the essential factor in the success of any foundry enterprise applicable to the methods in use, the clerks, the machines, the cupola, the cleaning room, as well as to the moulders and coremakers. Even a trifle of increase at each point will certainly result in greater earnings. It is the little things, which are oftentimes overlooked because they are little, that amount to something substantial in the aggregate.

Analysis, important as it is, is a *post-mortem,* a tearing-to-pieces-looking-for-trouble process, and while it is an important element in

pointing out the way to correct existing evils, it is just as necessary to have at work an *ante-mortem* process—a process anticipative in nature—a creative and constructive force—a force which considers that all work, while distinct, must be subservient to a general scheme of things, which admits of something being done with regard to its relation to other things—"organization" in other words, applicable to the business in its entirety, to the various departments, to the clerical work, etc., and definable as follows:

"The result of a resolving of the forces at work into their component parts; their classification so as to enable them to follow well defined channels, that the work may be guided along the most logical lines and responsibility placed where it properly belongs; and finally their combination into one harmonious effort, supervised and directed by a master mind."

A customer ordering castings will specify a certain analysis of the iron. He will want a certain percentage of silicon, sulphur, manganese, etc., and it is up to the foundry superintendent so to plan his work as to produce castings which when chemically analyzed will show how they fulfil the specification. In conducting your business, you specify a certain analysis—profits; perhaps you specify the margin of profit that you require your final analysis to reveal to you, and you must organize your business so that this final analysis will either come up to your desires or show you what was wrong in order for you to introduce the elements necessary to bring about the results you specified. There is no more excuse for a lack of organized effort in the foundry business than there would be for a foundryman to dump his different brands of pig iron, scrap irons, etc., onto one common pile.

An accounting arrangement, no matter how carefully planned and installed, can only *register* results, not *produce* them, but this does not mean that the accounting should be considered as of little or secondary importance; in fact, the forces which register or record the results, as well as those which produce them, must be well organized if maximum efficiency is to be the outcome. Let us therefore take up the matter of organization, first as applied to the accounting and then to the engineering branches, by briefly considering the following questions:

1.—Should the cost accounting be considered a part of the general accounting or be kept separate from it?

2.—Should the accounting be on the basis of monthly, quarterly, or yearly results?

3.—Should the inventory be a perpetual or continuous one or taken at regular periods for closing the books?

4.—Can mechanical aids be employed to advantage?

5.—Is a comprehensive accounting arrangement expensive?

6.—What may be expected from an efficient accounting arrangement?

One of the basic principles about which a system of foundry accounting should be built, is that it should consider the important fact that business as it is now conducted is nothing more or less than a conversion of assets from one form into another. A foundryman starts with cash in the bank, which he converts into labor and material. From this expenditure he secures castings which when sold appear as accounts receivable, then as cash, as payments are made, and so back into labor and material again, from one state into another, in the form of a complete circle. From this point of view, a foundry accounting arrangement, to be efficient, should consider the costing as a part of the general accounting scheme, in order that *all* items effecting the business can be properly recorded and not lost sight of. Cost information carried through the general books so that everything must be in balance, at the end of a period, is going to mean that the accounting will be more comprehensive than if the costing was a sort of spasmodic, hit-and-miss, incomplete and perhaps inaccurate sort of an affair.

It would not seem as if question two was entitled to any consideration whatever. It is difficult to explain why an executive will rest content, as so many do, with anything short of a monthly accounting, making possible a thirty-day statement as to his conditions. Cases are numerous, however, where a monthly trial balance and an annual or perhaps a semi-annual closing of the general books seems to be the custom. Twelve opportunities in a year for locating and correcting faulty conditions, as against one or perhaps two chances, is something worth considering, as it places an executive in much closer touch with the various details of his business than a yearly accounting possibly could—in fact, in the majority of cases, if results are not as they should have been, it is almost impossible to analyze a yearly statement so as to lay a finger on the leaks and the inefficient conditions which were responsible. As no manager in these days, can afford to "fool" himself or to work in the dark regarding what is going on all about him, we are safe in concluding that a thirty-day accounting arrangement is absolutely essential.

Regarding question three, as to the matter of a continuous inventory, a brief consideration should show that such an institution is not

only advisable but necessary, if the accounting scheme is arranged to make possible a thirty-day statement. Material is converted money and should be regarded just as carefully as the cash is; but how is this converted asset regarded by the majority of our foundries? Every reader can call to mind case after case where the proper care of the materials purchased is a matter of little concern; where careful attention is given to the matter of buying, but once the material arrives, this same careful attention seems to be conspicuous by its absence in so far as concerns the way this material is used. An item like torches and wicking does not seem to be of any great consequence, but how about the thousand and one items with which the foundry is concerned in the course of a year? Some workmen are careless by nature; others become so, even the most careful sometimes, when they realize that not only are there no safeguards thrown about the materials, but that it seems to be the duty of no one in particular to see to it that the materials are used judiciously. Even if a lax handling of the purchased materials does not result in making them careless, it tends to make them so; and at the same time it robs the executive of the means that might enable him to "cut corners." A concern which had been rather liberal in allowing their workmen to use waste as they saw fit, decided to place the issuing on a more systematic basis with the result that in the first month the consumption was reduced by about 25 pounds—a small item, perhaps, but an item which in a year meant 300 pounds less to pay for. No more material should be purchased and used than is necessary to produce good results, and the less an executive has to pay for, the more he can use in other directions. As the aims of a continuous inventory is to furnish the executive an efficient control of his materials, so that he can know that this expenditure is not out of proportion to the results obtained, it should need little argument to convince a foundryman that purely from the standpoint of good business, of possible financial gain, a positive knowledge of his material is something to be desired. Even if it did not save him a cent, he would at least know that because of this control of things, he has not wasted any money.

As to mechanical aids in accounting, I am of the firm belief that they can be used to decided advantage in any foundry office. What an executive wants is a knowledge of his results as quickly as they can be gotten to him, and if he is forced to depend upon his clerks to add columns of figures, multiply and divide, without the aid of mechanical devices, he must either employ a large force of clerks or wait for his information until it is too late to be of value. A progressive manager should do neither when an installation of machines

makes it possible not only to operate with a minimum number of clerks, but to secure his information on time. One of the most prominent manufacturers of adding and listing machines has a machine peculiarly adapted to the needs of the foundry business, in that pounds-hours-dollars can be added at one time, materially reducing the work of summarizing production costs according to the various classifications. There are several makes of multiplying and dividing machines, any one of which will pay for itself within a short time, as they not only make the work easier for the clerks but enable them to do their work with much more rapidity—the most important result being the absolute accuracy with which the machine can be made to operate.

Is a comprehensive accounting arrangement an expensive proposition? To arrive at an answer to this question, let us place the expense of operating a foundry with the simplest kind of an accounting arrangement in contrast with one which is designed to give the desired information. In the first place let us assume that in a foundry running at a capacity of 25 tons daily there are employed, in addition to the executive, an office manager at $100 per month, to look after the purchasing, orders, etc., and a bookkeeper at $75 per month, who with a stenographer at $40 per month can look after the accounting and the balance of the office work. This would amount to $2,580 yearly, or 35 cents per ton. To place the accounting on a proper basis, it would perhaps be necessary to add to the above a foundry clerk at $65 per month, an office clerk at $40 per month, a stores clerk at $50 per month, and an office boy at $30 per month, a total of $2,220 more a year, or 30 cents per ton, which (on the basis of a cost of $50 per ton for the castings produced) would mean an extra clerical cost of less than one per cent as a cost to make possible a proper accounting arrangement.

As to what may be expected from a comprehensive accounting arrangement, it can be said that the principal result would be clear and concise statements reflecting the conditions of the business. Not very high sounding, perhaps, but full of meat just the same. A hospital doctor arranges for information concerning his patients during his absence, and at regular intervals, the nurses and attendents register in a systematic way the important details concerning pulse, temperature, etc., which upon the arrival of the physician will show him the condition of the patients during the time he was away from the hospital. He knows whether they are better or worse, and from this information plus his knowledge of the cases, he is in a position to plan out his future action. A manufacturer is the doctor of his

own business, his statements and charts being the information as to pulse, temperature, etc., a study of which will enable him to plan for the future. Figures in themselves are dry and uninteresting, but with reason and judgment (analysis) applied to them they assume a far different aspect. To illustrate. A correct accounting scheme would show what the total production was in a certain period and it would also show the number of hours in which this production was made. Placed by itself, this information would mean very little to the executive beyond the fact that his plant worked a certain number of hours and that his production was a certain amount. If however, these figures should show in addition that this production in the time specified meant 500 pounds per man per day, the executive would have something in the way of valuable information, for by comparing this figure with the relative production per man for previous months, he could satisfy himself from his knowledge of the work, as to whether the result was satisfactory or not. Analyzing still further, he could get the relative production of the work for Jones, Smith, and Brown, and would perhaps find that on the work for Brown the production fell below what it should have been. It is fair to assume that by concentrating his attention on the production of Brown he would be able to increase it to some extent, any increase being accompanied by decrease in the cost to produce the work, consequently more profit —this added profit being the result of an arrangement which reflected the condition of only one feature of the business. There are many other possibilities in this reflection process, but the one given is sufficient for purposes of illustration. At any rate, from the above arguments we can decide in favor of an accounting arrangement which will not only be accurate and efficient but designed to show the pertinent details of the business in a simple yet comprehensive manner.

Efficiency is the elimination of inefficiency—once it is found. It therefore becomes the duty of the executive so to arrange his details as to allow this "finding" process to work to advantage, which can best be done through means of a correct and well balanced organization. Human nature is liable to pass over the possibilities for profit when some one else is likely to receive credit for the good that is done, but once put a responsibility squarely up to an employee, letting him understand that while he will be held strictly responsible for failure, he will receive credit for accomplishment, and from that moment better results may be hoped for. In other words, the incentive to do must be furnished, for there is nothing that will do more to create harmony and promote action than mutual trust. Noncon-

formists must of course be weeded out or swung into line, for there can be no successful business without authority. This can be accomplished through the force of organization and personality much more easily than it can be by the force of fists. Men cannot be made to do a thing, but they can be led. The employee owes a duty to his employer, to be sure, but this does not mean that this duty is all one-sided. Make the organization what it should be—place responsibility where it properly belongs—furnish a man with an incentive to look for the troubles which exist to a greater or less degree in every business, and the inefficiency will be brought to light, for efforts will be made to bring about increased productivity, and increased productivity is synonomous with increased efficiency.

For example. There are no doubt a number of foundries where the rule is for the moulder to take out their work after pouring off, remove clamps and gaggers and temper the sand for use again. Here is an inefficiency which may not have been noticed simply because it was not up to anyone in particular to do more than was required of him. Results may have been satisfactory and consequently good dollars are being thrown away because of this faulty condition. What does it mean in dollars and cents? Suppose in a shop, fifty men take 1½ hours per day to remove their work and clean up before beginning the real work for which they were hired. Assuming that the production is at the rate of 400 pounds per man per day, these fifty men could produce, in the hour and a half that is lost, 900,000 pounds, or 450 tons, in one year worth, we will say, $60 per ton or $27,000. This is not the only result, for not only would the work of taking out the castings at night cost considerably less than the amount paid to the moulders, but the moulders would be producing 460 pounds per man per day instead of 400 pounds—any increase in the amount produced resulting in a lower cost per ton for burden.

Suppose that we take another example showing the possibilities in increasing productivity. In a certain foundry we will say that the daily production per man is 450 pounds, which through careful management is increased to 500 pounds. Chart 3 in my second article* shows that at 450 pounds the cost is $51.50 per ton, while at 500 pounds the cost is $50.00 per ton—an increase in the production per man of 50 pounds, or 11.1 per cent, accompanied by a decrease in the cost of $1.50 per ton or almost 3 per cent. On the basis of fifty producers, the smaller production would mean in a year a total production of 3,375 tons which at $51.50 per ton would be $173,812, while on the basis of 500 pounds per man per day, the yearly production

* THE ENGINEERING MAGAZINE, Nov., 1908, page 223.

would be 3,750 tons which at $50.00 per ton would be $187,500 in cost or an increase in the cost of $13,688. The result as far as production is concerned is an increase of 375 tons during the year, which at $60 per ton as a selling price would mean $22,500 in increased sales, and this amount less the cost of this increased tonnage—$13,688—leaves $8,812 on the yearly profit on the additional amount produced. Nor is this all there is to consider. We are still getting $60 per ton for the 3,375 tons which had been costing $51.50 per ton, but because of the increased tonnage are now costing $50.00 per ton, so that on the 3,375 tons we are making an additional profit of $1.50 per ton or $5,062 and this with the $8,812 profit mentioned above means a total yearly profit of $13,874—the result in dollars and cents of an increase in the productivity of the workmen.

Let us for a moment consider another phase of the subject—the losses due to faulty organization. A moulder usually has five things to work with—flasks, patterns, cores, gaggers and clamps, sand, and sometimes a sixth item can be added to these—special rigging like anchors, core barrels, etc. If things are not planned out as far in advance as possible we are likely to see moulders waiting for flasks, and if they are not suited to the work, waiting until the carpenter either cuts a part of a flask bar away or knocks out a bar or two so that new ones can be added. Or we may see a moulder waiting for his pattern, or waiting until the foreman ascertains whether the pattern is the right one or not, or the pattern may have to be sent back to the pattern shop for some repairs, or if the moulder attempts to make the casting from the pattern as it stands he must spend some little time in patching up his work in order to make the casting according to the pattern. Or again, we may see a moulder going after his cores and chatting with his fellow workmen on the way to the core room and back, or waiting because the cores are not quite ready, or perhaps they were neglected by the core-maker and have not been made at all, or perhaps they have been made and made wrong. We may also see a moulder digging into the back end of his floor for gaggers and clamps, and if he does not find all that he wants or what he wants, he may be seen on a "borrowing" expedition, or he may wait until some are brought to him from the supply—if there is one. We may also see him start on a piece of work, stop and go for some sand, or wait until the sand is brought to him by one of the laborers. As for the special rigging, we may either see the moulder going for what he wants or waiting until it is brought to him. We may also see some little time wasted in the morning because the new work coming in has not as yet been handed by the foreman to the moulders most

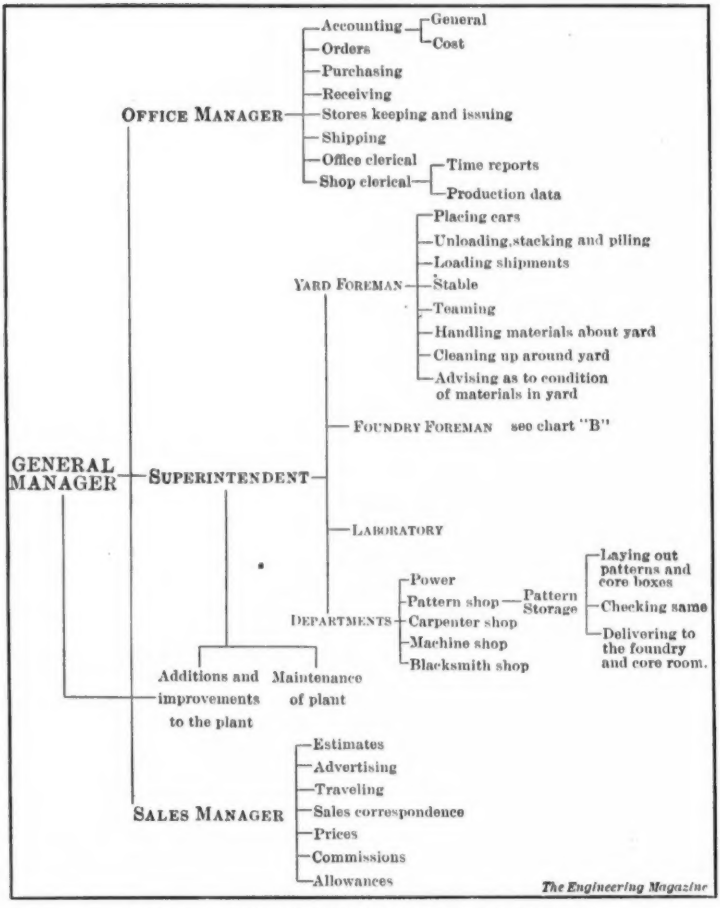


CHART A. GENERAL ORGANIZATION OF THE FOUNDRY.

competent to make it. Time not only costs money but production as well, for if we assume that with fifty moulders, 20 minutes is lost each day because of the waiting, delays, mistakes, annoyances, etc., that are often to be found in our foundries, we are not only losing, on the basis of $3.00 per day, labor amounting to $1,494 in a year but the lost time to the extent of 4,980 hours. If this lost time could be made to yield at the rate of 400 pounds per man per day, the result would be 199,200 pounds as increased production, or 100 tons, which at $60 per ton would mean $6,000 more in sales yearly.

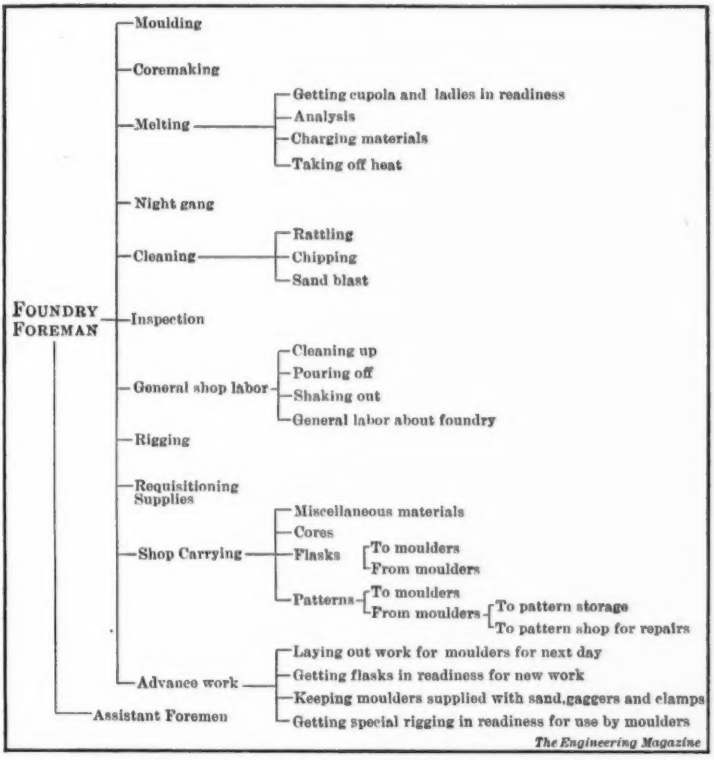


CHART B. ORGANIZATION OF WORK UNDER THE FOUNDRY FOREMAN.

Authority should be carefully defined and then centralized along the lines suggested in the charts, which accompany this paper; criticism and recommendations for betterments should be solicited and acted upon, and once those connected with the organization can feel that their opinion is desired in matters affecting their own work, it will not be long before they will be on the lookout, all along the line, for the loose ends, the leaks, the inefficiencies; and as a man looking for trouble is sure to find it, so will the man looking for places which can be bettered be better able to locate them than he who goes about with his eyes closed.

THE NATURE AND CHARACTERISTICS OF THE NEW STEELS.

By O. M. Becker.

II. THE EFFECT OF ALLOY METALS ON THE PROPERTIES OF STEEL.

In a preceding article Mr. Becker discussed the physical constitution of steel and the nature of the changes caused by tempering. In this concluding paper he takes up in detail the influence of each of the ordinary alloy elements. The discussion as a whole provides one of the most complete reviews of the subject yet presented in English.—THE EDITORS.

IN a preceding article we have examined into the composition and structure of steel as disclosed by chemical and metallographic methods, and we have discussed the phenomena of hardening and the changes in structural condition which it involves. We came in conclusion to the effect which the several substances alloyed with steel exercise on these changes of condition.

Not only do the several hardening metals act more or less differently with respect to the transformation points or temperatures at which steels containing them change from one to another of the three conditions already described, but they produce somewhat different physical properties. Vanadium, for example, even when present in very small proportion, tends to make steel very tough, increasing its tensile strength to an extraordinary extent. A vanadium steel in the form of wire has been reported as having a tensile strength of 400,000 pounds per square inch! This is so astonishing as to raise some doubts concerning the accuracy of the report. A test not open to doubt, however, made by a large steel-making concern, yielded the following results with a two-inch bar:

Elastic limit, pounds per square inch	222,200
Tensile strength, pounds per square inch	227,300
Elongation, per cent	11.5
Reduction of cross section, per cent	42.0

The proportion of vanadium in this steel was almost infinitesimal, being but 0.17 per cent., as shown in the following partial analysis:

	Per cent.
Carbon	0.34
Sulphur	0.025
Phosphorus	0.027
Manganese	0.40
Chromium	1.00
Vanadium	0.17

Another steel recently put upon the market for use in machine parts rather than for tools, is claimed to have a tensile strength in

excess of 272,000 pounds, in bars. The makers decline to give out its composition, but it evidently is a chrome-vanadium steel.

As is well-known, carbon also confers greatly increased tensile strength, though in a degree scarcely comparable to that conferred by vanadium; while on the other hand it tends, as the content becomes high, to increase brittleness. Very high carbon steel (and also high manganese steel) has been made so hard that it could be pulverized like glass.

It is rather difficult to arrive at exact conclusions with reference to the influences of the several metal hardening substances, from the circumstance that ordinarily several are present simultaneously in any steel undergoing tests. Some manganese, silicon and carbon, for example, are always found in steel, it having so far been impossible to eliminate them wholly in the process of manufacture. Even if it were possible to determine separately the influence of each element, it may be doubted if results arrived at in this way could be considered conclusive; for apparently in all cases, and certainly in some cases, their mutual influence tends to modify their individual effect—as already instanced of tungsten and manganese—and perhaps even to nullify it wholly or in part. Much experimenting, however, has been done; and while perhaps it is yet too soon to state full and final conclusions concerning the utility and limitations of the alloy elements, the investigations of Dr. Guillet, Mr. J. M. Gledhill, Professor Carpenter, Messrs. Taylor and White, Mr. C. A. Edwards, and others, make it possible to give interesting general conclusions and to indicate in some cases, at any rate, their limitations in high-speed steel. The following statements are believed to summarize the present state of knowledge upon this subject.

The influence of carbon in ordinary steel is so well-known as scarcely to need repeating here. It is sufficient to say that this metalloid increases tensile strength and hardness, and when high makes steel very brittle, as already indicated above. It has been previously shown that at low temperatures the carbon and iron are combined as pearlite, which is soft, with an excess of hard and brittle cementite or soft and tough ferrite according as the carbon content is above or below 0.89 per cent; and that at higher temperatures, up to where the steel becomes "burnt," this structure is replaced by the very hard and strong carbide called martensite or hardenite, while the excess of carbon above 0.89 per cent forms the hard but brittle carbide called cementite, which tends to make the steel brittle.

In high-speed steel its influence is much the same, and in addition it combines with tungsten, molybdenum, chromium, and the like

metals, to form carbides; one soft, brittle, and not permissible in a high-speed steel; the other, formed upon the destruction of the first at a very high temperature, hard, and essential to this kind of steel. The best modern high-speed steels are low in carbon, rarely in excess of 0.7 or 0.8 per cent, and frequently much lower—indeed, in some cases there is only as much carbon as it has been impossible to keep out, none being intentionally put into the mix. The strong affinity of carbon for iron and other constituents of high-speed steel makes this slight amount quite sufficient for the formation the high carbides which give these steels their peculiar characteristics.

The maximum limit seems to be near 2.0 per cent. Low carbon renders the steel more forgeable than high, and avoids the brittleness accompanying the latter. The proportion of carbon does not materially affect the cutting speed if between the approximate limits of 0.85 and 2.00 per cent. The degree of hardness in high-speed tools, as in the case of ordinary steel, depends largely upon the proportion of carbon. Hardness, however, is not an essential property of high-speed steel, though for most purposes it is desirable, especially in cutting exceedingly refractory materials. "Red-hardness," on the other hand is, according to Taylor, the one distinguishing property of high-speed steel by virtue of which it is able to resist to so marked a degree the softening effect of heat and therefore to stand up so astonishingly under heavy work. According to the same authority this property does not at all depend upon the carbon content, and is not even noticeably affected by variations in the carbon content up to about 1.3 per cent, and possibly above.

Tungsten, like carbon, imparts hardness, though to a considerably less degree. At the same time it imparts, when in combination with certain other alloys, if not alone, also the quality of red-hardness; and this in proportion to the amount present, up to 16.0 and perhaps 19.0 or 20.0 per cent. Higher tungsten adds nothing to the cutting efficiency, and on the contrary decreases the property of red-hardness and consequently the cutting efficiency when used in cutting tools. With a tungsten content ranging between 18.0 and 27.0 per cent, according to Gledhill, the steel becomes softer and tougher, but does not stand up well. Taylor indicates that its limits of highest efficiency appear to lie between 6.5 and 8.75 per cent approximately, and that it is most effective when combined with approximately 5.0 to 6.0 per cent of chromium. He also leaves it to be inferred that tools low in tungsten are deficient in red-hardness and rapidly deteriorate. Somewhat less than 1.0 per cent of tungsten appears to be necessary to develop this property, even in the presence of moderately high chrom-

ium. In the manufacture of high-speed steel tungsten is more largely used than any other of the hardening elements, because of its comparative cheapness, as well as because of the special qualities it imparts in combination with certain other elements. Of itself it does not make steel self-hard, as has been already shown, except it be heated to a very high temperature; and it is not yet certain that it, of itself, imparts red-hardness. Most likely it does not. In order to make a tungsten steel red-hard, and therefore high-speed, the tungsten must be combined with manganese, chromium, nickel, or perhaps other elements; and that in a pretty definite proportion, it would seem.

Mention has been already made of the formation of tungsten-iron carbides at moderate temperatures, and the transformation of these soft and brittle crystals into very hard and strong carbides at very high temperatures. When these carbides are compound, that is, are carbides of not tungsten and iron alone, but of manganese and chromium, and possibly other elements, then the mass of steel permeated by them resists wear and moderate degrees of heat in the manner characteristic of high-speed steel. It is red-hard.

Molybdenum very closely resembles tungsten in its influence upon high-speed steel, but is almost twice as active. From 4.0 to 4.5 per cent of molybdenum therefore is sufficient to make a tool high-speed. The difference in the amount required, however, is fully offset by the present higher cost. It is frequently found in high-speed steels, though not usually to replace tungsten entirely. It does not seem to answer so well as tungsten, for along with desirable properties molybdenum imparts also certain others which are not desirable, and which may even be fatal to good tool service. The tendency of molybdenum tools is to be brittle, to fire-crack, to be weak in the body, or to be irregular. Mr. Taylor thinks the latter defect very likely due to slight variations in heating, the critical limits between which this must be done probably lying close together. This seems to be indicated by the fact that cutting tools made of molybdenum steel run best when heated to a temperature slightly lower than is usual with other high-speed steels; and also that when heated above 1,000 degrees C. (1,840 F.) they are inferior and have short life. When combined with tungsten in small proportion, molybdenum is said by Gledhill to increase slightly the efficiency of tools. Like tungsten it does not affect the transformation points, whether much or little be present, until the steel has been first heated to a very high temperature, almost to the melting point, so that the double carbides, formed at the lower temperatures, are destroyed.

Chromium is now considered one of the most important alloys

used in high-speed steel. It adds greatly to the tensile strength of hardened steel when present up to 5.0 per cent, and allows it to be readily forged at a very high heat. It acts like tungsten and molybdenum in the formation of soft and brittle double carbides of iron and chromium, which are broken down at high temperatures, the steel then becoming self-hard in the austenitic or γ (medium hard and tough) state if the chromium be high. It tends to raise the critical points, and in combination with tungsten or molybdenum imparts the property of red-hardness. It confers a hardness somewhat like that conferred by carbon, which however is modified by the toughness also imparted when the chromium is not excessively high, the molecular cohesion of the steel being then much greater than in carbon steels. The steel in consequence is strong and tough, unless the chromium be very high, in which case the tendency is toward brittleness, as in the case of high carbon. Chromium steel, especially when vanadium also is present, is well calculated to resist the stresses and shocks incident to the work of high-speed steel. Since chromium confers hardness, obviously high chromium indicates the need for low carbon. In some respects it behaves like manganese, for a tool high in chromium will be self-hard and high-speed even though the managanese be very low, or even quite absent. Its range of greatest effectiveness appears to lie between near 1.0 and about 6.0 per cent. High chromium tools are very hard and very efficient upon refractory material. They are however easily injured by overheating and require care in hardening. Tools low in chromium are very tough and work well on soft materials.

Chromium-tungsten steels have this important advantage over most other high-speed steels: they are treated with comparative ease, requiring less special knowledge and skill to make efficient tools of them. They melt, nearly all of them, at about 1,375 degrees C. It is unnecessary, however, to heat them to this point, for a temperature of 1,260 degrees C. will confer just as much red-hardness as will the higher heat. There is, therefore, a range of considerably more than 100 degrees C. within which the heating may be done with perfect safety and without variation in the efficiency of the tool. As pointed out elsewhere, it is the very narrow limits within which the heating must be done that makes certain other high-speed steels so liable to produce defective or inefficient tools. Within the range indicated above there is a sufficient variation in the color of the heated steel to make it possible to gauge the temperature with the eye closely enough for most purposes.

The precise effects of vanadium are not yet fully understood. Its

power of conferring high tensile strength upon steel, even when present in very small proportion, has been already mentioned. Dr. Guillet points out that vanadium, forming double carbides as in the case of the other alloys already described (which however are not destroyed at high temperatures even), does not lower the transformation points and therefore does not of itself make steel either self-hard or high-speed. Neither does it confer the quality of temper-resistance or red-hardness, though it does seem to retard the formation of carbides. When present to a maximum of 2.0 per cent vanadium allows tools to be readily forged. Such tools also stand up well, but no better than do chromium tools. Vanadium is not now generally used to replace chromium, but to supplement it. Thus used its effective range seems to be approximately from 0.15 to 0.35 per cent. Excess over this proportion adds little, if anything, to the quality of tools. It does not follow, however, that no more than this amount of vanadium is put into steel, during the making; for it is asserted that it is not unusual for as much as 0.3 per cent of it, added to the contents of a crucible before melting, to have entirely disappeared by the time the steel is analyzed. The explanation is that minute quantities of it act to cleanse the steel, removing certain obscure oxides perhaps, combining with them and being carried off in slag. It is certain however, that small amounts placed in the melting crucibles add very materially to the quality of high-speed steel, tending to make it mechanically sound and homogeneous and to give it a tough molecular structure. A peculiar quality it imparts, to a greater degree than any other of the alloy substances, is that of self-lubrication. This obviously is a very desirable quality in high-speed tools especially.

Nickel, much used for armor plate and steel intended to resist wear, frequently in combination with chromium, though found in some high-speed steels is not very much used for cutting tools. It is more often used, usually in combination with chromium, for rock drills, and rock crushing machinery, shoes and dies for stamp mills, and other parts subjected to violent and repeated shocks. Since nickel confers toughness and greatly increases the elastic limit of steel, its combination with chromium produces an excellent steel for the purposes mentioned, though it does not appear to be of any marked advantage in high-speed cutting tools. Nickel has been mentioned along with manganese as a typical steel-hardening substance. It acts, when alone in steel, to lower the transformation points in proportion to the amount of alloy present; and in sufficient quantity, makes steel self-hard in the martensitic state. Still higher nickel, like higher manganese, tends to make steel self-hard in the austenitic state. Such steel

however does not seem to be high speed to any considerable degree—which is to say, neither of these elements seems to confer the property of red-hardness, either alone or in combination with the other. Nor does chromium seem to help in this respect, as it does when added to tungsten or molybdenum.

Cobalt, so closely resembling nickel in its general characteristics, does not seem to behave very much like it when alloyed with iron. It apparently has little, if any, effect in lowering the transformation points. Cobalt steel therefore is not self-hard, but usually is of a pearlitic structure (soft). It has, however, a tensile strength rather higher than that of carbon steel, though scarcely comparable with that of nickel steel. The utility of cobalt as an alloy in high-speed steel remains to be shown.

Titanium has been used in small proportion in some high-speed steel, and to a considerably larger extent it has been used in the manufacture of other steels. It is reported to add greatly to the hardness, tensile strength, and elastic limit of steel, closely resembling vanadium in this respect, though Dr. Guillet seems to think its influence unimportant. Information is lacking as to whether or not titanium can be used to replace other hardening elements to any considerable extent. It is so widely distributed and is so cheap compared with the other hardening substances used in high-speed steel, that its exploitation in this direction will be watched with much interest.

Unlike titanium, the ores of uranium occur but rarely. Some experiments have been carried on to determine the utility of uranium as a high-speed steel alloy; but thus far it has not been shown to add any important qualities which are not obtainable by the use of cheaper elements already much used.

Aluminum, often used in the manufacture of ordinary steels as a purifier during the making process, does not appear to add any desirable quality to high-speed steel, and so far as can be learned is not much, if at all used in its manufacture.

Until recently very little was known of what is perhaps the most curious of all the metals, tantalum. For the matter of that, a good deal still remains to be learned concerning it. Like most other hardening elements, it readily combines with carbon; but the carbides thus formed are not soft, as is the case with the others, but very hard. A small amount of carbon is sufficient to carbonize a large amount of tantalum. It is considerably more than twice as heavy as iron, bulk for bulk; is about as hard, when in the annealed state, as soft steel; and has a tensile strength nearly a third higher. When hardened by alternate heating and hammering, metallic tantalum becomes so hard

that a diamond drill will scarcely touch it, while at the same time it retains a remarkable degree of toughness. No information is at hand as to its specific influence upon high-speed steel, but it is known that one maker uses tantalum in steel for drills, dies, and tools of like nature. The strong affinity of tantalum (when hot) for oxygen makes it necessary to heat tantalum steel under special conditions that will prevent contact of the heated steel with the air. The electric furnace is mostly used for this purpose. Tantalum ores are rare, and ferro-tantalum (the form in which it is used) is costly.

The importance of manganese in the manufacture of steels of all kinds, and its influence upon high-speed steel in combination with tungsten, have been already mentioned. Like nickel and chromium, manganese seems to hinder the formation of the double carbides of tungsten and molybdenum. Steel containing these elements in combination with a sufficient proportion of manganese (or of nickel or chromium) therefore are self-hardening without the high heat treatment, though they are not necessarily high-speed to any considerable extent, even when they receive that treatment. Very high manganese makes steel cold-short (brittle when cold) and susceptible to fire cracking. Low manganese does not, apparently, affect the property of red-hardness or temper resistance; but it does tend toward strength and toughness in the body of a tool, while at the same time allowing it to be readily forged and annealed. The apparent effective range of manganese content lies between about 0.2 and 1.2 per cent. If above 2.0 per cent in connection with low carbon, the steel is likely to be very hard and brittle, unless the percentage is also above 6.0 per cent. The tendency seems to be to substitute chromium for manganese above 1.2 per cent. The chromium seems to do the work better than manganese beyond this point, and does not cause the undesirable tendencies above mentioned.

Silicon, like manganese, has an important function in the manufacture of steel; but in the proportion usually met with, has no important influence upon the structure or physical properties. An iron-silicon alloy containing from 5.0 to 15.0 per cent of the latter can be readily forged cold, like nickel; but is not forgeable at a red heat. Very high silicon increases the hardness of steel, and at the same time greatly increases, the brittleness. A singular circumstance is that an alloy of about 20.0 per cent silicon becomes harder when slowly cooled than when quenched. In high-speed steel high silicon sensibly lowers the cutting speed, though up to about 3.0 per cent it is said to increase the efficiency, especially upon hard material. Taylor indicates that 0.15 or thereabouts is, generally, most satisfactory.

Sulphur and phosphorus are as difficult to keep out of high-speed steel as out of other steels; and while they probably are slightly less harmful than in carbon steel, nevertheless they should be kept as low as possible. The former in steel tends to make it red-short and the latter cold-short. More than 0.03 per cent of phosphorus is ruinous.

It is seen from the above that while there are several agents more or less adapted to steel hardening, most of them are not well enough known, possess certain negative qualities, or are too rare to be available at the present time. Tungsten, molybdenum, chromium, manganese, and vanadium, besides possibly titanium, are now in general use to give tool steel properties not conferred by carbon, or to enhance the influence of that element. As has been already mentioned, the influence of any of these elements separately is not necessarily the same as when combined with others; and indeed in most cases there seems to be considerable difference, as for example in the case of tungsten and manganese or tungsten and chromium, already referred to. So far, therefore, it has not been possible to work out theoretically a formula for a high-speed steel mix. The method has necessarily been that of cut and try, further development being along the lines indicated by more or less successful mixes.

If Mushet steel was not strictly speaking high-speed, it was at any rate the forerunner of high-speed steel, and the development of the latter grew out of the former. Analyses of self-hardening steels have been previously given. The composition of the original self-hardening steel, R. Mushet Special, has been frequently given:

	Per cent.
Carbon	2.0
Tungsten	5.0
Chromium	0.5
Manganese	2.5
Silicon	1.3

Analyses of several typical self-hardening steels were given in a preceding table.* The average composition of some twenty brands of self-hardening steel, as determined from an analysis of each, is shown in the table on page 987, together with the average composition of about twenty-five brands of good high-speed steels as made within a year or two of the present time.

A first glance at this table does not reveal any striking or apparently essential difference between high-speed and self-hardening steel; and indeed it is stoutly maintained that there is no such essential difference—that Mushet steels are high-speed if treated by the Taylor-White high-heat process. Indeed, when it is remembered that it was with self-hardening or Mushet steels that Taylor and

* THE ENGINEERING MAGAZINE, February, 1903, page 802.

COMPOSITION OF SELF-HARDENING AND HIGH-SPEED STEELS.

	Self-hardening.			High-speed.			Steel recommended by Taylor as best all-round cutting steel.	
	Average.	High.	Low.	Average.	High.	Low.		
Carbon	1.8	2.4	1.1	0.75	1.28	0.32	0.682	0.674
Tungsten	7.3	11.6	4.5	18.00	25.45	14.23[1]	17.81	18.19
Molybdenum	4.58[2]	...	....	3.50	7.6	0.00[2]	....	....
Chromium	1.6	3.4	0.07	4.00	7.2	2.23	5.95	5.47
Vanadium	...	...	....	0.30	0.32	0.00[3]	0.32	0.29
Manganese	1.8	3.5	0.08	0.13	0.30	0.03	0.07	0.11
Silicon	0.56	1.04	0.16	0.22	1.34	0.43	0.049	0.043
Phosphorus[4]	0.032	0.080	0.016	0.018	0.029	0.013	....	....
Sulphur[4]	0.015	0.050	0.004	0.010	0.016	0.008	....	....

White were experimenting, and that it was these that yielded high-speed steels when subjected to the high-heat treatment, it becomes evident that though not now identical, there is a very close relationship between them. An inspection of the table above will show that the chief differences in composition are these:

High-speed.			Self-hardening.		
		Per cent.			Per cent.
Carbon	Medium or low	0.3 to 1.3	High		1.0 to 2.5
Tungsten	High	14.0 to 25.0	Low		4.5 to 12.0
Chromium	High	2.0 to 7.0	Low		0.1 to 3.5
Manganese	Low	0.03 to 0.3	High		0.08 to 3.5

The differences, it will be observed, are entirely of degree, and not of kind. The total amount of alloy is very largely increased, and in every case the proportions of the ingredients named are inverted. This of course makes a very great difference in the qualities, though not necessarily in the characteristics, of high-speed steel and of the older self-hardening. The quality which particularly characterizes high-speed steel is red-hardness, the property of resisting the drawing of the temper when heated even to a red color. But red-hardness is imparted to the alloy steels (suitable ingredients being present) chiefly by the high-heat treatment—that is, by heating these steels to the point where they become austentitic, or *γ* whichever one chooses to name this moderately hard and tough condition. It is natural to suppose that all austentitic steels would necessarily be red-hard to a high degree. This however does not seem to be the case, though indeed the two conditions usually are found together in greater or less degree.

[1] Tungsten is used in all but one of the steels analyzed. In combination with molybdenum the percentage of tungsten is lower than that given.

[2] Molybdenum was found in but one of the self-hardening steels, and in six of the high-speed steels, in the latter always (with one exception) combined with tungsten. The minimum percentage so combined was found to be 0.48.

[3] Found in but three of the steels analyzed.

[4] The exceeding difficulty of determining such infinitesimal quantities as are involved in the separation of phosphorus and sulphur makes these figures more or less uncertain. In most cases it is possible only to say that traces of these elements exist.

Thus far, in high-speed-steel practice, the disposition on the part of users as well as makers, has been to use one steel for all purposes, tools for cutting hard as well as soft materials (wood among the rest), forming dies, crushers or hammers, rock drills, and all the rest of the category of tools. Most manufacturers make rather extravagant claims for universal high efficiency on behalf of their particular steels. It is true that some steels on the market come pretty close to fulfilling the various conditions requisite to universal service, not only making good cutting tools for hard and soft metal and wood, but being suitable also for forming dies, crushing tools, hammer tools, and the like. For the most part however the high-speed steels now on the market are adapted to particular rather than general service. Thus a steel highly efficient in cutting hard material often is not so on soft; and one well suited to cutting is not very likely to be well suited to forming dies and the like. Mr. Taylor mentions one steel tried in his experiments as being superior to all others in all kinds of metal cutting, and gives its composition as follows:*

	Per cent.	Per cent.
Vanadium	0.32	0.29
Tungsten	17.81	18.19
Chromium	5.95	5.47
Manganese	0.07	0.11
Carbon	0.682	0.674
Silicon	0.049	0.043
Phosphorus	....	....
Sulphur	....	....
Iron (presumably)	75.119	75.223

Though nothing is said as to its efficiency in tools other than those for metal cutting, the composition of this steel indicates that it is also good for all tools requiring toughness and wearing quality; so that it may fairly be classed as an all-round steel. Other things equal (price, for example) it would be highly desirable to have in a shop or set of shops one all-round steel equally and in a high degree efficient in all sorts of work there commonly turned out. The need for so many varieties of tool steel heretofore has been a source of great inconvenience, frequent mistakes, and untold annoyance—which all would be dissipated could a single steel be economically substituted for all the varieties now in use. But though this is a consummation greatly to be wished, it has been shown that conditions are not equal. Recently steels have been put upon the market, at prices very greatly below those commonly asked for the ordinary grades of high-speed steel, which are especially adapted to some particular class of work,

* The analysis of this steel is included also in the table at page 987, last column. Taken from "The Art of Cutting Metals," Mr. Taylor's presidential address, American Society of Mechanical Engineers, meeting of December, 1906. Practically all references here made to Mr. Taylor's statements and opinions are based on this report.

as wood cutting, for example. No analyses of these steels is at hand, but they are stated to be intermediate between the high-speed steels and ordinary steels, and evidently are developed from the ordinary self-hardening steels by varying the alloy content so as to secure the highest degree of toughness and edge-holding quality, essential to tools not expected to stand up to the kind of work required of high-speed tools; rather than red-hardness, which is not essential to this class of tools. They purport to fill a gap which has been recognized ever since high-speed tools first came into general use, furnishing a tool possibly slightly less lasting in service, but at a considerably lower cost. The precise field for these steels remains to be determined. Doubtless they will come largely into use for wood working and such metal-working tools as require keen edges but work in such a way (perhaps at slow speed) that they do not get hot enough at the cutting edge to need a high degree of red hardness. Some of them are stated to be especially adapted to use in forming and blanking dies, drop dies, and the like tools which require great wear-resistance, but which also generate no great amount of heat while at work. It remains to be seen whether or not any of these steels can fill the place which high-speed steel only lately has come to fill effectively and efficiently—the use for forming and other dies subjected to tremendous pressures. High-speed steel dies of this sort are very likely to split, and there has been a real need for a steel which would just fit into this use.

The minute structure of high-speed steel, as seen in a fracture, does not differ very greatly from that of carbon steel. It is, in general, seen to be of a fine and uniform granular appearance, with the granules smaller and more uniform, generally, than those of carbon steel. In annealed and forged high-speed-steel the smoothness of structure is increased; and when hardened, the crystalline structure stands out clearly though the individual crystals are very minute.

Under the microscope the structure is seen to be essentially that of carbon steel with certain modifications or additions. Pearlite is found, though generally in smaller proportion than in carbon steel, and martensite (or hardenite) forms a considerable proportion in many cases. This is true, as might be expected, especially of those steels which are high or moderately high in carbon, and which therefore are quite hard. Austenite is nearly always present in high-speed steel which has been heated beyond the higher critical point, and of course indicates that the steel is tough in proportion to the amount present. Changes in appearance and in structure due to hardening, tempering, and forging, are as noticeable in high-speed steels as in carbon steels.

PRODUCTION AND PROSPECTS IN THE COPPER-MINING INDUSTRY.

By Arthur Selwyn-Brown.

THE copper-mining industries were successful throughout the world last year, notwithstanding the commercial depression experienced in most countries. The total output of copper in 1908 was about 715,000 long tons. Of this, the greatest output ever recorded, the mines of the United States contributed 59 per cent.

In the early part of 1908 many of the leading American mines were closed down for short periods or were worked on a reduced scale for various reasons. In the latter part of the year, however, they were mostly operated to the fullest extent, and many new mines became producers. Among these the Ely mines, in Nevada, started with a steady output of 3,000,000 pounds of copper monthly. This has resulted in the production of copper overtaking the demand, and it would appear that if these conditions continue throughout the present year, the United States copper production in 1909 will exceed that of last year by more than 60,000 tons. Naturally this overproduction of copper in a period of reduced prices has caused serious apprehension in speculative copper-trade circles regarding the outlook of the copper industries in the near future, notwithstanding the fact that only two years ago the demand for copper was greater than the available supply. In this article it is proposed to review briefly the present position of the copper industries and outline conditions on the principal copper mining fields.

Copper Production and Prices.

The production of copper and the average price of lake copper in New York for each year in the period 1880-1908 is given in Table I. The figures in this table clearly show that there is a steady increase in the annual production of copper and that the United States are becoming of greater importance each year as factors in copper mining. In the past 28 years the United States copper output has increased from 17 per cent of the world's annual output to nearly 60 per cent. This ratio is still increasing. Little or no connection is noticeable between the price and the output. The average price of copper during the past 28 years was a little over 13 cents per pound.

TABLE I. WORLD'S COPPER PRODUCTION, 1880-1908.
(In Long Tons.)

	World.	Foreign.	United States.	Percentage of U. S. Production.	Price per lb. in New York in Cents.
1880.....	153,959	126,959	27,000	17	21.50
1881.....	163,000	131,000	32,000	19	18.20
1882.....	181,622	141,155	40,467	22	19.01
1883.....	199,406	147,832	51,574	24	16.50
1884.....	220,249	155,141	64,708	29	13.00
1885.....	225,592	151,540	74,052	32	10.67
1886.....	217,086	146,656	70,430	32	11.00
1887.....	223,798	142,781	81,017	36	13.85
1888.....	258,026	156,972	101,054	39	16.78
1889.....	261,205	159,966	101,239	38	13.49
1890.....	269,455	153,489	115,966	43	15.60
1891.....	279,391	152,552	126,839	45	12.76
1892.....	310,472	156,454	154,018	49	11.56
1893.....	303,530	156,497	147,033	48	10.75
1894.....	324,505	166,385	158,120	49	9.52
1895.....	334,565	164,648	169,917	50	10.73
1896.....	373,363	167,979	205,384	54	10.98
1897.....	398,955	178,384	220,571	54	11.36
1898.....	429,156	194,106	235,050	54	12.05
1899.....	469,310	215,440	253,870	54	11.76
1900.....	485,854	216,743	269,111	57	16.65
1901.....	511,019	242,497	268,522	51	16.72
1902.....	542,167	247,870	294,297	54	12.16
1903.....	585,081	273,499	311,582	54	13.72
1904.....	641,694	278,955	362,739	56	13.01
1905.....	701,252	298,615	402,637	57	15.89
1906.....	212,000	302,266	409,734	58	19.60
1907.....	710,000	309,866	400,134	57	20.00
1908.....	714,464	293,323	421,141	59	13.42

PRODUCTION OF VARIOUS COUNTRIES.

The contributions of the principal copper-producing countries to the world's output during the past nine years are shown in Table II. The growing importance of Japan, Peru, and Canada as copper producers is well shown by the figures given.

UNITED STATES PRODUCTION.

Copper deposits occur in nearly every State in the Union and in the territories. The largest deposits at present worked, however, are in Arizona, Montana, Michigan, Utah and Nevada. The production of the various States during the period 1902-1908 is given in Table III.

An enormous amount of new capital is at present being invested in copper mines and smelters in the United States. Large as the production is today, it promises to increase rapidly in the near future. It is estimated that when the new properties at present undergoing development are in full operation, the mines of the United States will produce at least 75 per cent of the world's copper. Table III shows that the great producing States at present are Arizona, Montana and Michigan. Utah and Nevada last year showed remarkable

TABLE II. OUTPUT OF PRINCIPAL PRODUCING COUNTRIES. (In Metric Tons.)

	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.
Argentina	76	793	244	137	157	157	107	224	200
Australasia	23,368	31,371	29,098	29,464	34,706	34,483	36,830	41,910	39,000
Austria-Hungary	1,377	1,356	1,626	1,407	1,473	1,346	1,458	1,062	1,000
Bolivia	2,134	2,032	2,032	2,032	2,032	2,032	2,540	2,540	2,300
Canada	8,595	18,575	17,765	19,360	19,490	21,588	19,106	21,022	24,316
Cape of Good Hope	6,828	6,503	4,521	5,314	7,900	7,442	6,645	6,838	6,700
Chile	26,016	31,299	29,373	31,424	30,592	29,632	26,157	27,112	26,000
Germany	20,635	22,069	21,951	31,214	30,262	22,492	20,665	20,818	20,000
Italy	2,797	3,048	3,424	3,150	3,388	2,997	2,911	3,353	3,000
Japan	28,285	27,916	30,251	38,610	35,408	36,485	40,528	49,718	51,000
Mexico	22,473	33,943	36,357	46,040	51,760	70,010	62,690	61,127	38,259
Newfoundland	2,929	2,800	2,906	2,753	2,235	2,316	2,332	1,758	1,600
Norway	3,998	3,429	4,638	6,010	5,502	6,406	6,218	7,122	6,500
Peru	8,353	9,673	7,701	7,925	6,863	8,763	8,641	10,744	9,000
Russia	8,128	8,129	8,814	10,485	10,871	8,839	10,658	15,240	15,000
Spain and Portugal	53,718	54,482	50,587	50,536	47,788	45,527	50,109	50,470	51,000
Sweden	457	457	462	462	542	559	508	2,032	2,000
Turkey	2,341	1,665	1,118	1,422	965	711	432	1,270	1,100
Great Britain	777	610	488	544	501	726	762	711	700
United States	274,933	270,998	288,833	316,239	370,892	397,003	416,226	398,736	432,907
Totals	496,819	532,148	542,209	602,832	663,327	699,514	715,523	733,807	727,474

TABLE III. UNITED STATES COPPER PRODUCTION, 1902-8. (In Pounds.)

	1902.	1903.	1904.	1905.	1906.	1907.	1908.
Alaska	———	1,339,590	2,043,586	4,900,866	8,685,646	7,034,763	4,800,000
Arizona	119,944,944	147,648,271	191,602,958	235,908,150	262,566,103	256,778,437	274,800,100
California	25,038,724	17,776,756	28,529,023	16,597,489	28,153,202	33,696,602	27,750,000
Colorado	8,422,030	4,158,368	9,506,944	9,404,830	7,427,253	13,998,496	10,166,370
Idaho	227,500	778,906	2,158,858	7,321,585	8,578,046	9,707,290	10,080,506
Michigan	170,609,228	192,400,577	208,309,130	230,287,902	229,695,730	219,131,503	226,500,000
Montana	288,903,820	272,555,854	298,314,804	314,750,582	294,701,252	224,263,780	244,446,447
Nevada	164,301	150,000	———	413,292	1,090,635	519,694	11,145,381
New Mexico	6,614,961	7,300,832	5,368,666	5,334,192	7,099,842	10,140,140	7,099,940
Utah	23,939,901	38,302,602	47,062,889	58,153,393	50,329,110	66,418,370	73,448,438
Other States	15,807,536	15,782,761	19,640,409	19,148,764	20,569,489	27,797,092	50,122,918
Totals	659,508,644	698,044,517	812,537,267	901,907,843	917,805,682	868,996,491	941,360,000

increases over their productions in former years. Great developments are taking place in these States. Within the next few years they will become much more prominent as copper producers.

ARIZONA.—The comparatively low price of copper last year had little influence on copper mining in Arizona. The price was barely less than the average price during the last twenty years, and, mine owners, knowing that the circumstances causing the depression in prices were but temporary, kept the mines in operation for the greater part of the year. Arizona is now producing more copper than at any previous period. The large smelters at Douglas, Globe, Jerome, Clifton, Morenci and Bisbee are in full operation. The United Verde smelter has been enlarged and mining facilities have been improved in the United Verde mine by the completion of the tunnel run to tap the ore bodies and drain the mine at the 1,000-foot level. The Calumet and Arizona mine is producing 5,000,000 pounds of copper monthly. In January, 1909, the Copper Queen smelter produced 9,500,000 pounds of copper. This is the best month's record made in Arizona. Prospecting operations are being actively pursued throughout Arizona and many new and promising mines are being developed. The present year will witness a remarkable revival in copper mining, also, in old localities which have long been dormant.

MONTANA.—The copper mines in Montana are at present giving employment to 11,000 men. In addition to the ordinary productive work, a large amount of development work is being done in most of the big mines and the smelters are being improved and enlarged. Very extensive development work is being done in the Minnie Healy and Rarus mines by the Butte Coalition Company. The average depth at which copper is being won on the Butte field is a little over 2,000 feet. The deepest shaft on ore is in the High Ore mine, which is 2,800 feet deep. Ore is being mined in the Anaconda mine at nearly the same depth. Last year the Anaconda was the largest dividend payer among the copper mines. Its dividends totalled $2,400,000 as compared with $7,800,000 in 1907. Since the company was organized in 1905, it has distributed over $41,000,000 in dividends. This is equivalent to 137 per cent on its capitalization of $30,000,000. The ore in the lower levels is diminishing in value. In ten years it has fallen from $15.93 to about $10.54 per ton and, although mining and smelting costs have been reduced, the margin of profit has fallen. It is believed, however, that the company will be able to operate profitably for several years on ore already developed, and as the workings are not very deep, future prospecting operations may open up new ground. It appears probable, however, that the

Anaconda will not be able to occupy the proud position of the greatest dividend payer among American copper mines many years longer. At the present time it costs the company a little less than 10 cents per pound to mine, smelt, and market its copper.

MICHIGAN.—The Lake Superior mines produced about 226,500,000 pounds of copper in 1908, as compared with 220,217,890 pounds in 1907, and 224,407,860 pounds in 1906. The various companies disbursed $5,074,136 in dividends, as compared with $13,469,950 in 1907, and $13,911,500 in 1906. The comparatively small sum disbursed last year was due to the low price of copper. Lake copper was quoted early in 1908 at 11¾ cents per pound, and at 14 cents in December. The average price realized by the mines was about 13 cents per pound throughout the year. The Calumet & Hecla mine continues the greatest producer and dividend payer on the field. Last year it produced 83,000,000 pounds of copper, compared with 88,000,000 pounds in 1907. The company's dividends in 1908 amounted to $2,000,000 as against $6,500,000 in 1907. Since 1880 this company's dividends amounted to $107,850,000, or a return of 4,314 per cent on its share capital of $2,500,000. The ore treated averages 2¼ per cent copper, or about 45 pounds of copper per ton of rock milled. This is of lower grade than the ore treated in former years. In order to balance the falling off in grade, the company is improving its mining and metallurgical plants with the view of reducing costs. A large re-grinding mill is being built which is expected to save about 4,000,000 pounds of copper that has hitherto been lost in the tailings. Most of the mining machinery is now driven by electricity. It costs this company a little under 8 cents per pound to produce copper at present. It is believed that this cost can be considerably reduced in the future.

In addition to the Calumet & Hecla there are eighteen mines producing copper ore in Michigan, and at the end of the present year several more will probably be mining ore. Very extensive prospecting operations are being carried on and these, it is believed, will lead to an increased production in the next few years.

ALASKA.—Extensive copper deposits have been developed in Alaska during the past few years. The Copper River deposits are, perhaps, the most promising. These cover a large tract of country around the head waters of the Copper River and extend well into the Yukon country. During the panic last year financial interests connected with the Amalgamated Copper and the recently-formed International Smelting companies secured control of many of the richest copper claims in the Copper River and other copper-bearing

localities in Alaska, in addition to the local railroads and large tracts of timber and coal lands. Very extensive mining and smelting works are planned, ample capital has been provided, and a large army of men will be employed next summer in opening up a number of large copper mines. These works are so extensive that it will be several years before the new mines are fully productive. There is little doubt, however, that within the next few years the copper output in Alaska will become more valuable than the gold output.

The copper production in Alaska in 1908 amounted to 4,800,000 pounds, as compared with 7,034,763 pounds in 1907. About one-third of the present production comes from mines near Prince William Sound. The balance is mined on the Kasaan Peninsula and the Copper Mountain district of Prince of Wales Island. The ores now being worked in Alaska average about 3½ per cent copper and carry from $2 to $4 in gold and silver. The ores in the interior districts are much richer.

NEVADA.—Nevada was formerly celebrated for the richness of its silver mines; at present it is attracting attention by reason of the richness of its gold mines in the Tonopah, Goldfield and Bullfrog districts. In the next few years its great copper production will arrest attention. Copper is found in many districts in the State, and deposits of immense size are being developed in the Ely and Yerrington districts. These deposits are similar in nature. They are composed of metamorphic porphyry and garnet rocks impregnated over wide areas with copper minerals averaging between 2 and 3 per cent copper per ton. The ore developed at present in the Nevada Consolidated mine, at Ely, is estimated at over 12,000,000 tons. The Cumberland-Ely and Giroux Consolidated are not so extensively developed, but they also have immense reserves of good ore. These ores are now being successfully smelted at the Steptoe Valley Smelter near Ely.

The Yerrington copper field is situated in Lyon County, 40 miles southeast of Virginia City and the famous Comstock mines. Ores of similar composition to those found at Ely, but richer in copper contents, are being mined over a large area. The Bluestone, Wabuska, Mountain View, Nevada-Douglas, Mason Valley, Nevada-Rockland mines are being developed and promise to be large producers. The Yerrington copper ores average about 3½ per cent copper.

UTAH.—The most promising copper mines in Utah are in the Bingham district. The ore bodies consist of an altered siliceous porphyry containing small grains of copper minerals disseminated throughout the rock. The average assay value of the ore is 2 per

cent copper, 0.15 of silver and 0.015 ounces gold per ton. The ore is mined by open cut with steam shovels and steam and electric tramways. There are eight large smelting works in Utah treating local copper ores and new works are in course of construction. The present smelting capacity is 9,000 tons of ore per day. Utah mines produced 73,448,438 pounds of copper in 1908, as compared with 66,418,370 pounds in 1907. The cost of production runs from 7 cents per pound at Bingham to 9 and 10 cents in other districts.

Cost of Producing Copper.

Until quite recently, copper-mining companies kept the cost of producing copper secret and even today many of the largest companies refuse to publish their production costs. There are many variable factors entering into the costs and no general figure can be given to cover production generally. As, however, the average price of copper during the past twenty-eight years was about 13 cents per pound and copper mining is a lucrative industry, it is evident that the average cost of producing copper is below 13 cents per pound. From the carefully collected figures given in Table IV. the cost will be seen to range from a little over 5 to 11½ cents per pound. Notwithstanding the great improvements that have been made in recent years in mining and metallurgical methods and the consequent reductions in costs, there is still room for further improvements, and it is possible that within a few years 5 and 6 cents per pound will not be considered at all unusual figures as copper costs.

Table IV. Cost of Copper Production.

Mine.	Situation.	Method of Mining Ore.	Cost of Copper Production in cts. per lb
Calumet & Hecla	Michigan	Shaft	8
Mohawk	"	"	11
Wolverine	"	"	7½
Tamarack	"	"	8
Baltic	"	"	9
Champion	"	"	9
Anaconda	Montana	"	10
Boston & Montana	"	"	11
Butte & Boston	"	"	10
Butte Coalition	"	"	10
Nevada Consolidated	Nevada	"	7
Cumberland Ely	"	"	7
Utah Consolidated	Utah	Open Cut	7
Boston Consolidated	"	"	7
United Verde	Arizona	Shaft	8
Tennessee	Tennessee	"	10
Rio Tinto	Spain	Open Cut	5½
Mount Lyell	Tasmania	"	7
British Columbia	British Columbia	Shaft	10
Burraga	Australia	"	8½
Great Cobar	"	"	8
Cananea	Mexico	"	8½

SUBSTITUTES FOR COPPER.

At various times when the demand for copper has been greater than the available supply and high prices ruled, attempts have been made to find substitutes for copper, but its only metallic rival today is aluminium. In Europe the price of aluminium is slightly lower than that of copper and it has been shown that for certain electrical purposes aluminium is preferable to copper. In Europe and to a less extent in the United States, aluminium is used for long-distance electric-power transmission cables. It is also employed for the windings of the field magnets of continuous-current machines, and for terminals, switches, switchboards, bus-bars, binding posts, and similar parts of electrical equipment.

The most remarkable features of the statistics of the industry are the large increases in the production of aluminium in the past few years and the reduction in the price of the metal. It is now selling at from 20 to 22 cents per pound in the United States and from 10 to 13 cents per pound in Europe. But, notwithstanding this remarkable increase in the production of aluminium, copper producers have little cause for apprehensiveness in regard to aluminium being substituted for copper. Both metals have distinct fields of usefulness, and when the price of aluminium falls still lower, as it must, the world's production of that metal will be almost totally absorbed in the manufacture of articles into which copper has never entered.

CONCLUSIONS.—The present condition of the copper-mining industries in the leading producing countries has now been rapidly surveyed. Everywhere, they were found to be in a sound and healthy condition, even in the face of the present low price of copper. The producers are nowhere pessimistic. They feel confident that the small demand for copper at present is due to causes that will soon disappear, and that with the revival in business throughout the world in the next year or two the demand for copper will again outrun the supply. They fully appreciate the fact that, after iron, copper is our most useful metal. Experience has shown that it can very profitably be produced at present prices and few producers will deny the accuracy of the statement concerning copper made by Mr. Carnegie:

"Although production is enormous and increasing apace, it fails to keep up with the demand, which more than in any other commodity is limited by price. If the current price could be reduced 35 per cent the demand would be doubled or tripled; if it could be reduced 50 per cent copper would replace iron for roofing, cornices, piping, and other constructional purposes so as to raise the demand tenfold if not more."

EFFICIENCY AS A BASIS FOR OPERATION AND WAGES.

By Harrington Emerson.

IX. WHAT THE EFFICIENCY SYSTEM MAY ACCOMPLISH.

With this article, Mr. Emerson concludes his series which began in THE ENGINEERING MAGAZINE for July, 1908. He has presented in this group of papers the fullest exposition yet made of "efficiency" ideals and practice. In the judgment of excellent authorities, he has developed more than a system; he has formulated a philosophy. Its possibilities reach farther and touch the individual more nearly than any phase of "conservation of resources" now under discussion. The indications of this evolution of efficiency ideals are clearly apparent in these concluding pages.—THE EDITORS.

WHEN we consider the astounding efficiency of Nature's operations in minute matters—in insect and bird flight, in the stored energy of the fish, in the light of the firefly, in the warmth of the mammal, in the pervasive divisibility of a perfume, in the pumping power of the sequoia—when we consider the wasted energy of the winds and waves, the lavish waste of the radiant heat of the sun and the stars—the conviction may well be forced upon us that if we could cover the whole process and cycle we would find these apparent wastes to be regenerative and recuperative processes, and that the universe will be no nearer extinction a hundred million years hence than it was a hundred million years ago. There is one thing of which Nature has an unlimited and exhaustless supply, of which it can afford to be lavishly prodigal; and this one thing is time. Because it counts not time, Nature's cycle may be wholly efficient, even as the slow oxidation of iron may evolve as much heat as the combustion of thermit; but mortals do not have unlimited time, and, in their haste, they have neglected efficiency which may perhaps still be destined to yield the basis for a higher and more universal morality than that afforded by either ancient religions or modern philosophies. Certain it is that the solution of the old problems seems easier when they are approached from this new point of view. Efficiency is not to be judged from preconceived standards of honesty, of morality; but honesty, morality, are perhaps to be reconsidered and revised by the help of the fundamentals of efficiency.

Efficiency is to be attained, not by individual striving, but solely by establishing, from all the accumulated and available wisdom of the

world, staff-knowledge-standards for each act—by carrying staff standards into effect through directing line organization, through rewards for individual excellence, persuading the individual to accept staff standards, to accept line direction and control, and under this double guidance to do his own uttermost best.

If we could eliminate all the wastes due to evil, all men would be good; if we could eliminate all the wastes due to ignorance, all men would have the benefit of supreme wisdom; if we could eliminate all the wastes due to laziness and misdirected efforts, all men would be reasonably and healthfully industrious. It is not impossible that through efficiency standards, with efficiency rewards and penalties, we could in the course of a few generations crowd off the sphere the inefficient and develop the efficient, thus producing a nation of men good, wise, and industrious, thus giving to God what is His, to Caesar what is his, and to the individual what is his. The attainable standard becomes very high, the attainment itself becomes very high, and as to all activities in a nation ought to be as high as in the travelling circus, where every performer, human or animal, is a star, whether bespangled in the ring or driving tent stakes, whether hauling wagons in work clothes or in work harness. Let not the reference to the circus be considered a drop from the sublime to the ridiculous, since in efficiency there is no great or small, and those who have been solving the problems of aerial flight have learned much from analysing the flight of obnoxious gnats, of foul vultures.

Nature counts not time, but there is no eternity for the individual who, though breakfast and dinner were plentiful, is hungry again at supper time. There is not an eternity of time for the corporation which may not indefinitely default on bond interest without dissolution; but the State is perennial, and no high national efficiency can ever be attained unless the State recognizes its function in the efficiency problem and takes over perennial, secular efficiency as its share of the work. The State has not hesitated in the past, does not hesitate now, to mortgage the future for the benefit of the present, as when it piles up an enormous debt for present luxuries, forgetting that Martinique, San Francisco, Valparaiso, Messina, are suddenly overwhelmed by earthquakes and other unforeseeable catastrophies which at any moment occur and tax to the utmost the viability even of an unmortgaged community. The State has not hesitated to annihilate the present for the sake of the future, as when it drafts its citizens into army and navy and slaughters them by the hundred thousand as in the Russo-Japanese and other wars.

It may be that even as ruthless foreign invasion and barbarous

conquest were the bane of antiquity, destroying the irrigation works of Nineveh, Babylon and India, so mortgage debts, not less ruthlessly although more slowly, may destroy modern communities and modern States. What would not have happened to England, weighted with her enormous Napoleonic debt, if the steam railroad, if the steamboat, had not been developed in the first half of the nineteenth century, if the stores of California and Australian gold had not, in a single decade, doubled England's trade, thus halving the relative burden of the debt?

Because the philosophy of efficiency is new, modern States have failed to recognize the chief modern justification for the existence of national government—namely, furtherance of national efficiency.

The theory of the interrelation of individual, corporate and national duties as to efficiency is as far as possible removed from the unnatural, and unworkable theories of modern socialism which work directly against efficiency, not for it, and it is equally far removed from the modern theories of State control which penalize, thwart, and interfere with efficient corporations, vaguely fearing that they are a menace to the State, as if the day, the month, the year, even the century or æon, can ever be a menace to eternity.

The function of the individual is not to drag down to the level of his own inefficiency the standards of the corporation, yet these are the avowed aims of modern socialism, of modern labor unions; the function of the corporation is not to drag down to its own competitive level the standards of the State, yet great business men have no higher ideal than to apply corporate method to the State.

The function of the corporation is not to lessen and hamper, but to promote the efficiency of the individual worker, by placing at his disposal all the resources attainable through the corporation, by directing his endeavors and by rewarding him individually, without limit, for efficiency.

The function of the State is not to substitute itself for the individual corporation on the monstrous supposition that all men are more efficient than the selected few, but to take over those secular efficiencies which are as much beyond the years of the corporation, even, as the corporation efficiencies are beyond the day needs of the individual. The function of the State is to act as staff guide and regulator to the activities of the corporate line, to use State powers for the reward of the efficient corporation, for the punishment of the inefficient corporation, even as the corporation uses a bonus based on efficiency to reward the efficient individual, uses penalties founded on efficiency records to eliminate the inefficient individual.

A certain marvelously wise corporation in New England, a corporation wiser than any other I know, laid down as its fundamental principles that it could not expect reliable and steady workers unless it guaranteed permanence of employment; that it could not expect workers above the average unless it offered them remuneration above the average; and it therefore determined its preliminary piece rates not on competitive figures, not on the extent to which it could squeeze down the worker, but on the basis of what a desirable worker ought to earn; and, finding these preliminary rates in many instances higher than those of its competitors, it reduced them, not by scaling down wage reward but by scaling up the productive capacity so that unit costs fell as effort and reward rose. Assuming that such a firm, that other great and wisely directed and managed concerns, attain the highest level of corporate efficiency—what are they to do when competitors elsewhere in the United States employ women and children at starvation wages for long hours, when necessary raw materials pay a heavy import tax, when foreign markets are hampered by discriminating tariffs; what are they to do when raw materials fluctuate in a single year perhaps as much as 100 per cent in value; when interest rates fluctuate between 4 per cent and 10 per cent; when demand for the finished product flows and ebbs like the tides in the Bay of Fundy? How would the efficiency of such a corporation not be supplemented and promoted if the national, State, and municipal governments were alive to their obligations to study and standardize conditions—if the municipalities, States, and central governments stayed out of the market when individuals and corporations were bidding it up, whether for materials or labor; if they came into the market with long matured plans for unhurried improvement, to be undertaken when individuals and corporations were in a period of lull? Why should there not be a minimum wage at which employment in national works, reclamation of arid lands, harbor dredging, canals, highways, battleships and fortifications, would be always open, thus doing away forever with the disgrace of bread lines? Why should a great nation like the United States be, at any moment, scarcely three months removed from famine? Why should the national Government not establish great central reservoirs of raw materials even as it establishes water catch basins to accumulate, in periods of glut—to supply, during periods of scarcity? Such a policy covering a dozen great staples of food, of textiles, and of mining products would finance itself and be in addition a source of revenue. Why should the Government not regulate the supply of money and rates of interest, by advancing freely and at a slowly increasing rate on

finished articles of manufacture or against great constructive works of corporations, thus equalizing production?

Why should the two great locomotive-building plants of the country be forced to produce in one year 6,000 locomotives, working overtime under uneconomical conditions, employing 50,000 men, and the next year drop to a production of 2,000, throwing 40,000 men out of work?

Why should the Government and the States and the municipalities not establish standards of hours and wages based on the capacity of able-bodied men, thus eliminating the necessity for either woman or child labor in factories?

Why should a Dingley Bill increase the tariff on stockings and socks, under the mistaken idea that the industry will be transferred to the United States—a purely protective, not revenue measure—the actual effect of the increase being to stimulate efficiency in Saxony, to raise wages in Saxony, so that the price in the United States does not rise, the tariff becoming a revenue, not a protective, measure? As against silliness of this kind, why should the national Government not use the tariff and also its own contracts as rewards for American efficiency? Why should it not say to the United States Steel Corporation, to the Standard Oil Company, to other great corporations: "Show that you are paying standard wages per day for standard hours per day in your mines, in your transportation enterprises, in your plants; show that from mines or wells to finished product you are using the most efficient processes known; show that in all respects you are eliminating needless waste—and then the great power of the tariff shall be used, not only to protect, if protection is required, but to open to you and to extend foreign markets."

No Government can ever rival in efficiency and production a modern corporation; it is folly for it to try; but it can stimulate, promote, and reward efficient corporations even as these stimulate, promote, and reward efficient individuals.

Let us beware lest the exhaustion of our national resources, of our forests, of our free lands, of our coal and iron mines, leave us stranded high and dry out of the running with the older nations of the world who, as Japan is already doing, accept and apply the Gospel of Efficiency.

We have not put our trust in Kings; let us not put it in natural resources, but grasp the truth that exhaustless wealth lies in the latent and as yet undeveloped capacities of individuals, of corporations, of States.

EDITORIAL COMMENT

The Panama Canal.

MR. KITTREDGE and several other distinguished members of the Senate seem greatly agitated over a comparison between estimates of the cost of the Panama Canal made some years ago by the Board of Consulting Engineers and the total sum of expenditures actually incurred to date. The Senator from South Dakota has put all the dramatic fervor at his command into a reminder to certain engineers that they "pledged their professional reputations" upon the statement that a "lock type canal" could be completed for $142,000,000. The Senator seems to forget the very great difference between could and would. An intelligent discussion of actual conditions "could" be presented before a deliberative body, but it is not likely that it "would" be by Senators who have so little grasp of the situation. In the first place we are not building a canal of the plan or dimensions contemplated in the estimate referred to. That, however, absolutely important in the matter of cost, is relatively a minor matter. The major difference is that we are not working, and under Government direction we never shall work, by methods that even approach in economy those certainly contemplated by the engineers who made the preliminary estimate. No engineer familiar with such methods has ever found it possible to apply them in the construction of the Panama Canal, and no engineer capable of carrying on work with the efficiency contemplated in the estimate, and free to choose his own employment, has ever been able to remain where he was compelled to endure the conditions of inefficiency characteristic of Government undertakings.

It has been left, we believe, absolutely with the distinguished Senators who spoke in the debate on February 10, to formulate the proposition that a sea-level canal "could" be completed at less cost than a "lock-type" canal. No one—not even the most earnest advocate of the sea-level plan—has ever before made this claim. The Board of Consulting Engineers (to which Senator Kittredge apparently refers) estimated the sea-level canal at $272,000,000, using the same unit prices in both projects, and every other commission has fixed substantially the same proportionate costs. Under no conceivable conditions could the cost of a sea-level canal be less than twice that of a lock canal. The same increase of cost for administration and inefficiency which will make the lock canal cost $375,000,000 under Government construction, would make the sea-level canal cost $600,000,000. The Senator's discovery to the contrary is unique. It is indeed gravely doubtful if it could be built at all. Competent engineers have expressed the belief that excavation could not be carried to the proposed dimensions, nor the slopes maintained, under the rainfall conditions on the Isthmus. It is in all probability true, as Mr. Taft has said, that agitation for the "sea-level plan" is tantamount to opposition to any canal at all. But if it were constructed on that plan, the tidal lock that would yet be essential would still retain the vulnerability of the "lock plan"; the Gamboa dam, fundamentally necessary to the tide-level project, would be far more dangerous than the Gatun dam involved in the present scheme; the narrow, tortuous channel which would alone be obtainable would involve greater menace to navigation than the lockage; and the risk of total obstruction or destruction by earthquake slips would be actually increased.

Nor has any one with the slightest knowledge of the subject ever assumed Senator Teller's position that the difficulty of controlling the Chagres River was a bugaboo—that "he took no stock in the Chagres." To the decision of statesmen so enlightened the plans for a great national enterprise would indeed be committed with a full heart. Fortunately Congress seems to understand the strong desirability of adhering to the present plans, and public opinion is constantly growing better informed on the question.

"Popular Science."

FROM this serious confusion in concept of a technical question, we may turn with unmixed joy to a new popular description of the oxy-acetylene blow-pipe. The enterprising press agent of an inventor kas been feeding the dailies with "news" of a "torch operated by oxygen and acetylene, radiating a heat of 6,500 degrees said to be the most terrific known to science." It "will cut through any known metal." In devising it, the inventor "tried combination after combination, but with indefinite success. Acetylene, the new gas produced from calcium carbide, attracted him. The intensity of the oxygen flame he knew well. He combined the two." Nothing could make this statement more delightful.

The Cut in Steel.

THE declaration of an open market for steel suspends, if it does not end, one of the greatest attempts ever made to maintain an artificial level of prices for a fundamental commodity—a level independent of cost of production, supply and demand, or general economic conditions. We seem to be in some danger now of swinging to the worst fluctuations of wholly unregulated and uncalculating competition.

It is a long while since such a situation has been recognized in the American steel trade, and meanwhile important changes in the position and proportions of the large producing factors have taken place. The outcome of this revival of the old order amid new circumstances perhaps cannot be reduced to mathematical certainty. At best, we learn so little from observation of industrial phenomena, and forget so soon what we have learned, that most of our lessons must be gone over again every few years. The demonstration of effects during the next few months might be of much ultimate and permanent value.

It is to be feared, however, that with abnormal conditions of general business, with approaching changes of the economic balance due to tariff alteration, and, most of all, with manipulations of conditions and of apparent consequences upon a huge scale for political and market effect, the lesson will reveal nothing of substantial import. Superficially, cheap steel would seem likely to stimulate construction, industrial investment and expansion, and hence general business; but the most important inducement to expansion—cheap money—has already failed signally to induce it. It is to be feared that new ventures will be not so much encouraged by the fact that steel is cheap, as deterred by the expectation that in a little while it may be cheaper. The net result, for some time at least, is likely to be increase of the feeling of uneasiness and distrust—of the unsettlement of confidence—which is the present chief cause of continued depression.

Our Foundry Series.

MR. KNOEPPEL'S review of foundry organization and costing reaches in this issue the completion of the general discussion of the subject. The development of the actual processes of accounting and the treatment of standardization will make another group of equal extent and importance. This second phase of the matter will be taken up after a short interval, an intermission of a few months having been decided upon, to relieve the present pressure upon the author's time and attention, and to avoid any risk of interference by other essential plans of the Magazine.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

GOLD MINING IN THE STRAIT OF MAGELLAN.

A REVIEW OF THE GEOLOGY AND DEVELOPMENT OF THE DEPOSITS AND OF MODERN MINING METHODS AND CONDITIONS.

R. A. F. Penrose—The Journal of Geology.

EXTENSIVE alluvial gold deposits, of which little is generally known but which promise to become of considerable importance, exist on both sides of the Strait of Magellan, in Patagonia and the archipelago of Tierra del Fuego. Both these regions are owned partly by Chile and partly by the Argentine Republic. The dividing line follows the Andes southward in Patagonia to the Strait of Magellan, thence eastward for some distance along the strait, and thence southward again through Tierra del Fuego, giving most of that archipelago to Chile, but an important part on the eastern side to Argentina. During the year 1907 Mr. R. A. F. Penrose twice visited the Strait of Magellan and investigated the gold-mining industry in that region. The results of his observations are contributed to *The Journal of Geology* for November-December, 1908, from which we take the following details of the occurrence of the deposits and the condition under which they are being worked.

Topographically Patagonia consists of two main divisions, the western part comprised in the main range of the Andes, dropping off abruptly on the Pacific side, and the low, rolling pampas of the eastern part which slopes gradually to the Atlantic. The archipelago of Tierra del Fuego exhibits the same geological and topographical features. The western and southern islands are rugged and mountainous, representing the southern extension of the Andes, while the northeastern part of the main island of Tierra del Fuego is similar to the pampas of eastern Patagonia and may be considered an extension of the same geological structure. In fact, the archipelago probably owes its condition as such to a partial submergence of the southern end of South America.

"The rocks of southern Patagonia and Tierra del Fuego have not been much studied, but from the little that is known of them, it may be said that in the mountainous areas they are much like those of other parts of the southern Andes, granites, various igneous rocks, and slates being common; while in the low pampas country in eastern Patagonia and the northeast part of the main island of Tierra del Fuego, more or less soft, sandy and argillaceous strata predominate, probably belonging mostly to the Mesozoic and Cenozoic eras.

"Gold is said to have been discovered in southern Patagonia by the Chileans over forty years ago, and is supposed to have been known to the native Indians at a much earlier date, but it has been produced in quantities sufficient to attract general attention only in the last twenty to twenty-five years. The gold in the gravels of Rio de las Minas, near Punta Arenas, was one of the earliest

discoveries, and a number of miners soon began to work there. Another early discovery was the gold in the beach sands near Cape Virgins, at the eastern entrance of the Strait of Magellan, which was first discovered about 1876, but not actively worked until 1884. Then considerable excitement followed and prospecting parties overran a large part of southern Patagonia and Tierra del Fuego. The search continued for several years with more or less activity, sometimes the excitement subsiding, and sometimes breaking forth again when an especially rich discovery was made.

"During this time, gold was found and actively worked in many places on both sides of the Strait of Magellan, but the principal localities were the following: the gravels in the Rio de las Minas near Punta Arenas; the beaches at Cape Virgins and from there southwestward along the shore to Point Dungeness; the gravels on several small streams to the eastward of where Porvenir now stands, across the strait from Punta Arenas; the beach at Paramo northeast of San Sebastian Bay, on the east coast of the main island of Tierra del Fuego; Navarin Island, Lennox Island, New Island, and Sloggett Bay in the extreme southern part of the archipelago near Cape Horn; New Year Island which lies north of Staten Island, at the eastern end of the archipelago; and several localities in the western islands of the archipelago. In fact, gold has been found to be very generally distributed almost all through the Magellan region, though only in certain localities has it been profitably worked. Most of the important localities yet discovered are in the archipelago of Tierra del Fuego, though a few, such as on the beaches at Cape Virgins and Point Dungeness, are in Patagonia on the north shore of the Strait of Magellan; and gold is also found in places along the southern coast of Chile, for some distance north of the Strait of Magellan.

"About the year 1904 the preparations to use steam dredges in handling the gold-bearing gravel started afresh the boom that had for a time been more or less quiescent. The old method of working the mines had been by hand, gathering the gold in pans, sluice-boxes, or other similar appliances. With the introduction of steam dredges, however, it became possible to handle the gravel much more cheaply and in much larger quantities. Since that time, though the excitement has subsided, work on the gold deposits has steadily progressed, and in a much more systematic manner than formerly. There were in 1907 some twelve or thirteen dredges in operation or being constructed, and the gold industry of the region promises soon to become a far more important business than in the days of handwork. The dredges are not used in handling the beach deposits, as the fury of the storms would soon batter them to pieces, and their use has so far been confined to the inland deposits.

"Until recently the largest gold-mining operations were at Paramo and Lennox Island, but since the introduction of the dredges, the most active operations are on the northwest part of the main island of Tierra del Fuego, just across the strait from Punta Arenas. Here the town of Porvenir is the headquarters of the industry. This town has been a small settlement for some years, but it jumped into prominence in the gold boom of 1904, and is now a prosperous mining center of about 800 people. The mines are mostly some miles, and often many miles, from Porvenir, but the town is the supply point and the port at which the boats of the miners land.

In addition to the Porvenir region, mining on a small scale, but of more or less importance, is still going on at some of the other localities already mentioned. The chief center of civilization in the whole region is the Chilean town of Punta Arenas, located on a good harbor on the Patagonian side of the Strait of Magellan. It bears much the same relation to this Antarctic gold region as does Dawson City to the gold fields of the Far North.

"The gold of the Magellan region, including the Strait of Magellan and Tierra del Fuego, is, so far as at present

known, most all in alluvial, or placer, deposits. Very few gold-bearing veins have been found, though it may be said that in a region so difficult as this is to prospect, gold-bearing veins might readily be overlooked. The alluvial deposits may be divided into two classes, those in beds of creeks or on hillsides, and those on sea beaches where they are subject to the action of the sea during rising and falling tides and during storms.

"The alluvial deposits in beds of streams or on hillsides vary in gold contents from a few cents to a dollar or more per cubic yard, and sometimes, though less commonly, are considerably richer, but most of the ground that is now worked is said to range from twenty-five cents to fifty cents per yard. Under the conditions existing in the region it is difficult to make very low-grade ground pay, but some of the operators expect eventually, with steam dredges, to make a profit on very considerably lower-grade ground than they are working now. The gold-bearing gravels vary from a few feet to many feet in thickness; ten to thirty feet or more being not uncommon. An 'overburden' or capping of barren ground, of variable thickness often occurs.

"The gold on the beaches is sometimes on the immediate surface and sometimes covered by from a few inches to several feet of barren sand. On some beaches it is well up on the shore, on others it is near the water level, and on still others it is below the water level. The sandy strata carrying the gold are rarely over a few inches in thickness, but often very rich. The gold is associated with large quantities of black sand, which seems to be mostly magnetite, and numerous small garnets.

"The gold, whether from the creeks, hillsides or beaches, is said to be quite pure, though it contains often a little copper and silver. It occurs generally in rather fine particles, but sometimes small nuggets, often flat and about the size of lima beans, occur, and occasionally still larger ones are found, but no very great nuggets have yet been discovered. The rarer minerals which occur in some other gold districts, like diamond, sapphire, topaz, etc., are said not to be found in this region, though a closer study of the deposits might reveal the presence of some of them.

"As regards the origin of the gold deposits of the Magellan region, it may be said that the alluvial deposits in the creeks and on the hillsides have doubtless been derived from the erosion of gold-bearing rocks, and though such rocks have not yet been found to any great extent in the region, they nevertheless probably exist and may sometime be discovered. If the Magellan region represents the partly submerged southern end of the continent, as already mentioned in this paper, many of these deposits may have been originally formed as ordinary alluvial deposits high up in the mountains, and brought down during the sinking era to a much lower level, while some of them may have been completely submerged in the sea. The gold in the beaches probably came largely from the later erosion of the alluvium in the creek beds and on the hillsides, and perhaps partly from old submerged alluvium from which the gold was thrown up by the sea. In either case the gold has been further concentrated by being washed over and over again on the beaches. It is said that the beaches, after having been carefully worked for gold, seem again to become rich in that metal after a storm or an unusually high tide. This phenomena is probably due partly to the action of the waves and currents in concentrating the gold which the imperfect methods of the miners have left behind in the sand, and partly to the washing up of fresh gold-bearing sand from depths that are undisturbed in ordinary weather or by ordinary tides. So well recognized is this enriching of the beaches that the miners, after working all the sand that can be profitably handled, wait for the next storm or very high tide to come, and then wash the same spots over again with a good profit.

"Prospecting in the Strait of Magellan and Tierra del Fuego is a more difficult

task than in most places. Most of the traveling is done in boats, as the land is much cut up by deep tidewater channels and bays, and covered with dense underbrush or immense peat bogs; while everywhere, even on the mountain sides, the soil is soft and boggy, so that walking is difficult and often impossible. Hence traveling in boats and stopping from place to place along the shore is the most practical way of prospecting; but here again another difficulty comes in, as the storms are frequent and violent. The climate, however, though stormy, is not extreme in temperature, the thermometer rarely going much below zero or much above 60 degrees. The mean winter temperature is about 33 degrees F. and the mean summer temperature is about 50 degrees F.

"Aside from the difficulties of prospecting, the industrial conditions under which gold is worked in this region are not as expensive as might at first be supposed. General supplies can be obtained at Punta Arenas at reasonable prices, for it is a seaport and supplies are brought there by ocean steamers at fairly cheap rates. The most expensive item is coal, and this is brought mostly from foreign countries. There is a small deposit of lignitic coal worked at what is known as the Loreto mine, a short distance from Punta Arenas, but the production is very limited and does not go far toward supplying the needs. There is also coal near Coronel and Lota on the Chilean coast, south of Valparaiso, but this is mostly used locally and by ocean steamers. In some parts of Tierra del Fuego there is a good deal of timber of the magnolia, beech, and other varieties, which can be used as fuel, but in other localities it is scarce. All over the region there is a great deal of peat, and efforts are now being made to use this as fuel.

"The season during which mining can profitably be carried on is about eight or nine months, from August to May, while during the rest of the year frost and snow hinder operations. The capital at present invested in the industry is mostly Chilean and Argentine, but it seems probable that, as the region becomes better known, other capital may be attracted to the gold deposits of this far-south country. No very definite statistics of the production of gold in the early days in the region are obtainable, but until recently it has been small, and probably not very many hundreds of thousands of dollars had been produced up to the time of the introduction of the steam dredges. With these, however, the production will probably be greatly increased."

THE FUTURE OF THE AMERICAN PORTLAND CEMENT INDUSTRY.

A DISCUSSION OF POSSIBLE REDUCTIONS IN OPERATING COSTS, FUTURE PRICE MOVEMENTS AND METHODS OF PRICE REGULATION.

Edwin C. Eckel—Association of American Portland Cement Manufacturers.

THE history of the American Portland cement industry up to 1907 was one of uninterrupted progress, so far as annual output was concerned. Up to that time cement production was a young and growing industry which had not yet reached the point where annual output is affected by financial conditions. Certain phenomena connected with the course of the industry in 1906, however, though apparently unperceived by the manufacturers, gave indication of an impending change in conditions. In the January, 1907, number of THE ENGINEERING MAGAZINE, Mr. Edwin C. Eckel wrote as follows: "The cement output, as yet, has not suffered markedly from financial depression. Prices have fallen off in poor years, it is true, but the annual output has always increased. The rise in yearly output from 1885 to 1906 has not only been continuous, but has even shown a tendency to increase its rates of growth. Of course such a condition of the industry cannot be expected to continue indefinitely. Within a few years we must expect to see the rate of increase low-

ered and finally, in some period of business depression, some year will show a lower output than the preceding year. This will mark the end of the youth of the cement industry, and the beginning of its period of maturity. Though the present condition of the industry is as prosperous as might be desired, it is possible that the change in rate of growth may be quite near at hand. New construction in 1906, and plans for 1907, will provide a great increase in mill capacity. If the succeeding years are generally good, this increase will be taken up without difficulty; but a general financial depression in 1908 would probably result in a temporary check to the cement industry. So far as can be estimated now, the plants which will be in operation before the end of 1907 will turn out cement at the rate of 50,000,000 barrels per annum, and it is doubtful whether such an output could be absorbed if the United States were not generally prosperous." Mr. Eckel's prophecy was ridiculed by a number of cement trade papers, but, as he took occasion to remind the members of the Association of American Portland Cement Manufacturers in a recent paper before that body, it has been amply fulfilled by the progress of events during the last two years. Henceforth the American Portland cement industry will stand on an altered economic basis. An outline of the future problems and possibilities of the industry is given in the following abstract of Mr. Eckel's paper, which was published in *The Engineering Record* for January 9, 1909.

"It seems fairly safe to say that the American cement industry reached a distinct turning point in the latter part of 1907. and that from now on the matter of output must be handled differently. Hereafter we may expect that the cement production will be related very closely to general business conditions; that in times of prosperity we may temporarily fall behind in capacity; but that the approach of business depression will be marked either by radical decrease in cement output or by its alternative, which is general demoralization in the trade. The cement industry has no longer room for poorly managed plants or for weakly financed companies, for in times of industrial stress such plants and companies become a menace to the entire industry."

The costs of Portland cement manufacture are, of course, much lower than in the early days of the industry. Part of the decrease is attributable to the gain in efficiency apparent in any well-conducted industry as machines and men gradually become more fitted to their work. But the bulk of the reduction in manufacturing costs can not be accounted for in this way. The great decreases came in three abrupt steps, coincident with three radical changes in the methods of manufacture, the introduction of the rotary kiln, the adoption of powdered coal as the standard fuel in the rotary, and the introduction of the long kiln.

"So long as there are absolutely no revolutionary changes in our present methods of cement manufacture, no marked decreases in operating costs can be expected. Improvements in grinding machinery can offer little in the way of cost reduction so long as the total amount of grinding to be done remains the same. The main elements in the problem are unfortunately fairly well determined by nature. To make 400 pounds of cement we must burn about 200 pounds of coal, and pulverize almost 1,100 pounds of material, raw mix, clinker and kiln coal. As coal can hardly be expected to decrease in price in the future, and as the other elements of cost are practically unchangeable, there is little room left for further economies. It seems safe to say that the manufacturing costs at well-conducted plants reached in 1904, 1905 and 1908 low levels which can hardly be lowered in the near future.

"The Portland cement industry is now characterized by moderate and decreasing returns to the investor. This condition is caused by the fact that, while free competition is slowly but steadily pushing downward the selling prices of the product, manufacturing costs on the other hand are almost stationary." Prices, if left to absolutely unrestricted

competition, will tend to fall to a point which yields a fair profit only to the largest and best mills. Some reasonable degree of price regulation, exercising control in both directions similar to that which now protects the steel trade against wild fluctuations of prices, would seem, therefore, to be a necessity. The simplest system of price regulation is, of course, the pool. Pooling agreements, however, have no legal status; and, while a number of pools have been formed in the Portland cement industry, none of them has had any great length of life. In fact, no form of pool in any industry can be considered durable.

"Since all of our financial history has established the ineffectiveness of any possible form of simple pooling to maintain prices of any commodity at reasonably profitable levels, it is clear that some other type of price regulation must be expected to appear in the cement industry. At present it is difficult to say just what form the final regulating process will take, for the Portland cement industry of this country affords a peculiarly interesting example of an important and growing branch of manufacture whose future organization and control are still matters of uncertainty. During the past few years, however, two distinct movements have become noticeable, and one or both of these may aid in the solution of the problem. The first, which is the normal occurrence in any industry containing a large number of independent competitive units, is the gradual growth of community of interest, which by increasing the size of some of the units, or by decreasing their number, aids in giving stability to the market. The second important movement is toward a control of the trade through the ownership of patents. This form of regulation, though not entirely new in American industrial history, is still much rarer than the other type.

"Ten or even five years ago the business of making Portland cement in the United States was confined to a number of comparatively small mills, each of which was practically independent. Today there is a noticeable degree of concentration of interest in the industry, and three processes are to work to increase steadily this concentration. Owing to the peculiar character of the industry, the final result is still a matter of much doubt. It is clearly impossible for any one organization to gain control of the supply of raw materials, so that in this industry the most effective basis for monopoly is not available. The ownership of comprehensive basic patents would afford a peculiarly serviceable type of control, inasmuch as patent monopolies are thoroughly legal in form.

"Setting aside for the moment the possibility of monopoly, it can be said that the three factors which make for concentration of control are: 1. The normal growth of profitable plants. 2. Consolidation by stock control. 3. The growth of the patent-holding company.

"A well-located and well-managed plant always has opportunity for expansion which is denied to plants of less technical or financial soundness. Many plants in this country have had opportunity for growth, and some have seized these opportunities. Plants which are built or extended at the height of a boom period, and companies which pay out all the profits of prosperous years as dividends can hardly expect to share in this growth. For in by far the majority of instances, lack of growth in a cement plant has been due, not to defective raw materials or to lack of technical skill, but to unwise financial management, either at the inception or during the active life of the company.

"As to the second factor mentioned, several strong groups of plants connected by stock control rather than by direct ownership are now in existence, and a number of smaller examples of 'community of interest' are known.

"The Portland cement industry, in its present form, is a comparatively recent development and owes much of its mechanical perfection to the efforts of American inventors. As a result of its recent origin, cement machinery and cement-making processes have been the subjects of innumerable patents, while older industries are more nearly free

from comprehensive claims. While many mechanical details are of course covered by minor patents, those claims which are likely to have any serious effect on the future of the industry may for convenience be grouped as follows:

1. Patents relating to specialized types of grinding machinery. Patents of this type are numerous and many are sound and valuable. Their only effect, however, is slightly to increase the cost of such machinery; and as the best representatives of the various classes of grinders are fairly well matched in efficiency, the net result is small.

2. Patents relating to the burning process. This group includes many and important claims covering kiln details, fuel burning methods, etc. Some of these patents have, as noted below, exercised an important influence on the industry and may become of still greater importance.

3. Patents on special products. Many patents have been issued covering cements differing more or less from the normal Portland type. Typical cases, for example, are the high-iron marine cements, the low-iron white cements, the high-magnesia cements, etc. Though valuable for certain uses, few of these special cements can be expected to exercise any appreciable influence on the general Portland cement industry. Their unimportance in this respect is largely due to the fact that most of them are more expensive to manufacture than an ordinary Portland. If it should develop, however, that some one of these special products could be made more cheaply than a normal Portland, the case would be very different.

4. Patents covering by-products. Claims for the recovery of valuable by-products, notably sulphur and the alkalis, are numerous; but so far none of these processes has proved to be of much practical importance.

"Regardless of what may be effected along the line of price regulation, it is probable that marketing conditions will, in the near future, be improved in some respects. Among the points to which attention may be directed in this field are the elimination of the 'optional contract,' the development of a warrant system, and the establishment of fixed basing points for quotations. The first of these appears to be a necessity, while the other two are at least open to discussion as to their worth in the cement trade.

"Since its commencement in this country the Portland cement industry has suffered, in common with all other lines of manufacture dealing with basic staples under a highly competitive regime, from a lax regard for contract obligations by purchasers. A buyer, placing a future order for cement or iron, felt apparently no obligation to take the product if the market price fell in the meanwhile. A contract was treated precisely as if it had been a free option, to be called only if prices advanced. It is fair assumption that the first result of increasing concentration of control in the cement industry will be to eliminate this abuse, as has been done in other lines.

"Ten years ago, when the American market was capable of absorbing all of the domestic cement output, even during times of general business depression, the export trade received scant attention, and deserved little. To-day, when depression means complete shutdown to many cement mills, the situation is very different, and a marked effort to develop foreign trade may be expected.

"The countries to the south of the United States are, in general, scantily supplied with fuel, and few of the existing Spanish-American coal fields are well located, with regard to transportation routes and markets. For this reason alone, these areas offer a very favorable field for cement exports from the United States, and as their development progresses this field may be expected to expand rather than to contract.

"While a competitive export trade is not of itself as profitable as a home market, it affords a valuable balance-wheel to domestic trade conditions. Under modern conditions there is always surplus capacity in the manufacture of staples. With depression at home, the surplus becomes disastrous, unless there is some way of disposing of it elsewhere."

THE COST OF CONCRETE CONSTRUCTION.

UNIT COSTS OF FORMS, REINFORCEMENT AND CONCRETE WORK IN TYPICAL STRUCTURES.

Leonard C. Wason—National Association of Cement Users.

THE valuable tables of unit costs of concrete construction in typical structures given below are taken from a paper read by Mr. Leonard C. Wason, President of the Aberthaw Construction Company, at the recent convention of the National Association of Cement Users and published in *The Engineering Record* for January 16. In making public data of the sort usually most carefully guarded Mr. Wason does not wish to be considered as acting from purely philanthropic motives. He sees in the ignorance of inexperienced builders who are entering in large numbers the field of concrete construction a danger of serious injury to the industry. The novice as a rule underestimates the cost of doing good work and his bids are unreasonably low. If he is honest and fulfils his contracts even at a loss to himself, the industry suffers through the demoralization of the true value of good workmanship; if he does poor work through the fear of losing money, the injury to the reputation of reinforced concrete as a structural material may have a very far-reaching effect. Mr. Wason's primary object in publishing accurate cost data is to reduce the pres-

Cost of Concrete Columns.

	Forms per square foot				Concrete per cubic foot						
	Carpenter		Nails &		Concrete	General		Aggre-	Team &		
Location.	labor.	Lumber.	Wire.	Total.	labor.	labor.	Cement.	gate.	miscell.	Plant.	Total.
Office bldg., Portland, Me...	.133	.039	.001	.173	.064	.004	.087	.084	.012	.022	.273
Coal pocket, Lawrence, Mass.	.057	.024	.001	.082	.166	.093	.072	.041	.008	.016	.307
Mill, Southbridge, Mass.....	.097	.082	.002	.181	.073	.056	.107	.035	.027	.030	.328
Mill, Attleboro, Mass.....	.093	.022	.001	.116	.110	.014	.062	.038	.013	.034	.271
Mill, Southbridge, Mass.....	.080	.056	.001	.137	.108	.048	.100	.037	.013	.034	.340
Coal pocket, Hartford, Conn.	.098	.047	.002	.147	.089	.043	.069	.055	.017	.013	.286
Garage, Brookline, Mass.....	.071	.051	.002	.124	.070	.028	.072	.058	.041	.020	.289
Warehouse, Portland, Me...	.118	.016	.001	.135	.087	.027	.087	.070	.039	.025	.335
Textile mill, Lawrence, Mass.	.061	.013	.001	.075	.095	.019	.109	.027	.018	.015	.283
Highest	.133	.082	.002	.181	.166	.056	.109	.084	.041	.034	.340
Lowest	.057	.013	.001	.075	.064	.003	.062	.027	.008	.013	.271
Average of 9.....	.082	.036	.001	.130	.096	.027	.085	.049	.021	.023	.301

Cost of Beam Floors of Reinforced Concrete.

	Forms per square foot				Concrete per cubic foot						
	Carpenter		Nails &		Concrete	General		Aggre-	Team &		
Location.	labor.	Lumber.	Wire.	Total.	labor.	labor.	Cement.	gate.	miscell.	Plant.	Total.
Power house, Greenfield.....	.165	.107	.003	.275	.143	.020	.109	.101	.008	.016	.397
Tar well, Springfield.....	.064	.041	.002	.107	.076	.005	.026	.075	.013	.040	.335
Mills, Greenfield, Mass.....	.106	.061	.004	.171	.077	.011	.109	.086	.007	.055	.345
Car barn, Danbury, Conn....	.044	.051	.001	.096	.128	.013	.086	.071	.011	.010	.319
Coal pocket, Lawrence, Mass.	.072	.039	.002	.113	.056	.004	.073	.041	.009	.019	.202
Mill, Southbridge, Mass.....	.067	.062	.002	.131	.137	.029	.191	.051	.038	.014	.460
Mill, Attleboro, Mass.....	.062	.032	.002	.096	.071	.023	.098	.062	.021	.055	.330
Bridge, Plymouth, Mass.....	.047	.050	.001	.098	.078	.019	.100	.040	.027	.010	.274
Garage, Newton, Mass.....	.104	.033	.002	.134	.116	.020	.121	.084	.038	.010	.394
Mill, Southbridge, Mass.....	.057	.051	.001	.109	.119	.027	.132	.037	.013	.034	.362
Coal pocket, Hartford, Conn.	.060	.033	.001	.094	.047	.023	.081	.055	.017	.013	.236
Garage, Brookline, Mass.....	.105	.028	.002	.145	.160	.032	.088	.058	.041	.020	.399
Filter, Lawrence, Mass.....	.048	.032	.001	.081	.102	.016	.085	.054	.012	.032	.301
Storehouse, Chelsea, Mass...	.004	.042	.002	.109	.153	.035	.115	.068	.052	.020	.443
Warehouse, Portland, Me...	.037	.029	.001	.067	.186	.030	.096	.069	.043	.046	.470
Textile mill, Lawrence, Mass.	.045	.042	.001	.088	.130	.013	.071	.037	.025	.010	.286
Textile mill, Lawrence, Mass.	.053	.033	.001	.087	.116	.033	.194	.049	.035	.015	.442
Chapel, Portland, Me.....	.052	.027	.002	.082	.100	.008	.127	.091	.041	.010	.377
Highest	.165	.107	.004	.275	.186	.035	.194	.101	.052	.055	.470
Lowest	.037	.027	.001	.067	.047	.004	.071	.037	.007	.010	.202
Average of 18.....	.070	.045	.002	.116	.111	.020	.106	.063	.025	.024	.354

Cost of Flat Slab Floors.

	Forms per square foot				Concrete per cubic foot						
	Carpenter		Nails &		Concrete	General		Aggre-	Team &		
Location.	labor.	Lumber.	Wire.	Total.	labor.	labor.	Cement.	gate.	miscell.	Plant.	Total.
Office bldg., Portland, Me...	.078	.029	.001	.118	.043	.004	.087	.084	.012	.022	.252
Fire station, Weston, Mass..	.067	.038	.003	.108	.103	.007	.092	.053	.026	.039	.320
Church, Boston, Mass.....	.067	.037	.002	.106	.146	.017	.109	.072	.020	.010	.374
Highest	.078	.039	.003	.118	.146	.017	.109	.084	.026	.039	.374
Lowest	.067	.037	.001	.106	.043	.004	.087	.053	.012	.010	.252
Average	.071	.038	.002	.111	.097	.009	.096	.070	.019	.024	.315

Cost of Concrete Slabs between Steel Beams.

Location.	Forms per square foot: Carpenter labor.	Lumber.	Nails & Wire.	Total.	Concrete per cubic foot: Concrete labor.	General labor.	Cement.	Aggregate.	Team & miscell.	Plant.	Total.
Bleachery, East Hampton....	.054	.027	.002	.083	.092	.007	.137	.073	.012	.046	.367
Machine shop, Milton, Mass.	.087	.027	.003	.117	.090	.033	.114	.075	.016	.034	.362
Foundry, No. Britain, Conn.	.078	.046	.002	.126	.095	.021	.076	.078	.004	.022	.296
Stable, Boston, Mass.....	.064	.012	.001	.077	.101	.019	.129	.070	.020	.015	.354
Residence, Milton, Mass.....	.110	.071	.003	.184	.105	.048	.132	.080	.053	.010	.428
Power house, Pittsfield, Mass.	.029	.030	.001	.060	.131	.008	.123	.068	.013	.010	.353
Laundry, Boston, Mass.....	.058	.024	.001	.083	.092	.021	.098	.089	.022	.010	.332
Prison, Portsmouth, N. H....	.068	.017	.001	.086	.073	.005	.208	.075	.006	.010	.377
Paper mill, Mittineague.....	.097	.071	.002	.170	.144	.033	.143	.062	.027	.010	.419
Power house, Quincy, Mass.	.047	.625	.001	.073	.073	.021	.159	.085	.064	.020	.422
School, Waltham, Mass.....	.029	.028	.001	.058	.138	.009	.102	.078	.018	.015	.360
Foundry, Providence, R. I...	.028	.020	.001	.049	.084	.012	.114	.026	.026	.010	.272
Foundry, Providence, R. I...	.043	.021	.001	.065	.111	.010	.128	.029	.029	.010	.317
Highest	.110	.071	.003	.184	.144	.048	.208	.080	.064	.046	.428
Lowest	.028	.012	.001	.049	.073	.005	.076	.026	.004	.010	.272
Average	.061	.032	.002	.095	.102	.019	.128	.068	.024	.017	.359

Cost of Building Walls above Grade.

Location.	Forms per square foot: Carpenter labor.	Lumber.	Nails & Wire.	Total.	Concrete per cubic foot: Concrete labor.	General labor.	Cement.	Aggregate.	Team & miscell.	Plant.	Total.
Fire station, Weston, Mass..	.116	.038	.004	.158	.100	.007	.069	.053	.026	.039	.294
Mill, Greenfield, Mass.....	.062	.058	.002	.102	.060	.011	.084	.086	.007	.055	.303
Water works, Waltham, Mass.	.137	.024	.001	.162	.146	.007	.058	.057	.014	.047	.329
Coal pocket, Lawrence, Mass.	.118	.056	.002	.176	.042	.004	.073	.043	.009	.019	.190
Mill, Attleboro, Mass.....	.103	.024	.001	.128	.129	.018	.074	.048	.017	.042	.329
Coal pocket, Hartford, Conn.	.096	.047	.002	.145	.118	.052	.097	.055	.017	.013	.350
Filter, Lawrence, Mass.....	.046	.632	.001	.079	.046	.017	.083	.054	.012	.032	.244
Ital'n garden, Weston, Mass.	.101	.073	.002	.176	.102	.008	.105	.081	.019	.010	.325
Stable, Beverly, Mass.....	.099	.030	.002	.131	.078	.019	.071	.062	.018	.010	.258
Residence, N. Andover, Mass.	.078	.016	.001	.095	.096	.014	.046	.059	.008	.010	.174
Observatory, Milton, Mass...	.056	.038	.002	.096	.095	.012	.060	.187	.058	.005	.417
Office, Boston, Mass.....	.105	.030	.002	.137	.096	.033	.066	.114	.066	.005	.380
Tunnel, Boston, Mass.....	.112	.045	.005	.162	.126	.016	.066	.106	.077	.005	.330
Hospital, Waltham, Mass....	.058	.028	.001	.087	.089	.017	.034	.063	.023	.010	.236
Residence, Boston, Mass....	.108	.036	.001	.145	.110	.015	.077	.069	.026	.005	.446
Coal pocket, Providence, R. I.	.087	.020	.001	.108	.052	.005	.102	.090	.015	.010	.274
Italian garden, Brookline....	.064	.027	.001	.092	.048	.011	.080	.071	.019	.010	.239
Highest	.136	.073	.005	.176	.146	.052	.105	.187	.077	.055	.446
Lowest	.046	.016	.001	.079	.042	.004	.034	.043	.007	.005	.174
Average of 17.....	.085	.036	.002	.128	.090	.016	.073	.076	.025	.019	.301

Cost of Foundation Walls.

Location.	Forms per square foot: Carpenter labor.	Lumber.	Nails & Wire.	Total.	Concrete per cubic foot: Concrete labor.	General labor.	Cement.	Aggregate.	Team & miscell.	Plant.	Total.
Filter, Warren, R. I.....	.103	.048	.004	.155	.062	.037	.086	.068	.012	.031	.296
Tar well, Springfield.....	.071	.031	.002	.104	.040	.015	.094	.075	.013	.040	.277
Tunnel, New Bedford.....	.048	.045	.001	.094	.213	.019	.203	.092	.057	.015	.599
Filter, Exeter, N. H.....	.124	.067	.002	.193	.064	.021	.071	.116	.034	.019	.325
Filter, Lawrence, Mass.....	.058	.043	.001	.101	.046	.017	.083	.054	.012	.032	.244
Theater, Portland, Me.....	.081	.024	.003	.108	.112	.013	.073	.078	.003	.020	.303
Warehouse, Portland, Me....	.053	.009	.001	.063	.040	.019	.060	.070	.029	.017	.235
Residence, No. Andover.....	.047	.019	.001	.067	.108	.006	.082	.045	.015	.010	.266
Filter, Lawrence, Mass.....	.048	.035	.002	.085	.055	.006	.039	.027	.011	.010	.148
Residence, No. Andover.....	.065	.019	.001	.085	.087	.013	.072	.045	.013	.010	.239
R't'g wall, Naugatuck, Conn.	.134	.047	.001	.182	.097	.013	.056	.032	.022	.010	.235
Hospital, Waltham, Mass....	.048	.028	.001	.077	.043	.019	.038	.063	.026	.010	.199
Greenhouse, Brookline, Mass.	.032	.035	.001	.068	.051	.007	.078	.043	.013	.010	.202
Hotel, Brookline, Mass.....	.037	.018	.001	.056	.043	.002	.080	.054	.010	.010	.199
Highest	.134	.048	.004	.193	.213	.037	.203	.116	.057	.040	.599
Lowest	.032	.009	.001	.056	.040	.002	.038	.027	.003	.010	.148
Average	.068	.033	.002	.103	.076	.015	.080	.062	.019	.017	.269

Cost of Footing and Mass Foundations.

Location.	Forms per square foot: Carpenter labor.	Lumber.	Nails & Wire.	Total.	Concrete per cubic foot: Concrete labor.	General labor.	Cement.	Aggregate.	Team & miscell.	Plant.	Total.
Power house, Greenfield.....	.119	.077	.002	.198	.065	.020	.098	.092	.008	.016	.299
Eng. foundation, Taunton...	.054	.025	.001	.080	.045	.002	.065	.048	.004	.017	.181
Head gates, Shawmut, Me...	.071	.043	.003	.117	.033	.001	.074	.099	.003	.014	.224
Canal, Lowell, Mass.....	.039	.025	.001	.065	.025	.011	.080	.078	.004	.042	.240
Foundation, Provincetown ..	.069	.043	.002	.114	.039	.004	.073	.099	.011	.049	.275
Dam, Merrimack, N. H.....	.066	.037	.003	.106	.081	.008	.090	.055	.008	.031	.273
Foundation, Boston, Mass....	.011	.006	.001	.018	.035	.004	.061	.072	.006	.010	.188
Eng. foundation, Boston....	.095	.039	.003	.137	.037	.013	.061	.084	.013	.015	.223
Gas holder, Springfield.....	.034	.031	.002	.067	.043	.001	.061	.068	.005	.010	.188
Foundation, Providence, R. I.	.016	.011	.001	.028	.051	.002	.047	.076	.010	.010	.196
Highest	.119	.077	.003	.198	.081	.020	.098	.099	.013	.049	.275
Lowest	.016	.006	.001	.018	.025	.001	.047	.043	.003	.010	.181
Average of 10.....	.057	.034	.002	.093	.045	.007	.071	.077	.007	.021	.229

COST OF FABRICATING AND PLACING REINFORCING STEEL.

Location.	Weight.	Cost of handling.	Cost per ton.
Office building Portland, Me	324½ tons	$5,115.32	$15.76
Fire station, Weston, Mass	8½ "	40.26	4.74
Mill, Chelsea, Mass	65¼ "	548.81	8.41
Coal bins, Dalton, Mass	8½ "	61.75	7.26
Dam, Auburn, Me	55 "	506.76	9.18
Filter, Warren, R. I	19 "	102.59	5.40
Tank, Lincoln, Me	8¼ "	69.38	8.16
Tar well, Springfield	15½ "	59.21	3.82
Monument, Provincetown	24½ "	136.84	5.58
Mill, Greenfield	92¾ "	1,232.01	10.20
Machine shop, Milton, Mass	20¼ "	177.16	8.75
Coal pocket, Lawrence, Mass	28 "	461.16	16.47
Mill, Southbridge	53½ "	142.76	2.67
Mill, South Windham, Me	293 "	3,079.60	10.51
Mill, Attleboro, Mass	49½ "	286.02	5.78
Garage, Newton, Mass	20 "	86.55	4.33
Mill, Southbridge, Mass	30 "	100.03	3.34
Coal pocket, Hartford, Conn	195 "	2,316.60	11.88
Filter, Lawrence, Mass	44½ "	112.84	2.54
Warehouse, Portland, Me	62 "	462.99	7.47
Standpipe, Attleboro, Mass	199¼ "	1,547.00	7.75
Highest			$16.47
Lowest			2.54
Average of 21			8.52

ent wild bidding and to do away with unintelligent competition. He admits that he does it the less reluctantly since the older firms in the field have little to fear from the beginner.

In addition to the tables which we reproduce and the discussion incidental to them, Mr. Wason's paper contains a great deal of valuable data on the methods adopted by his company for cost keeping on concrete construction work. He explains in detail the classification adopted in time keeping on various parts of the work, the methods of making reports of various kinds and the means by which actual costs are compared, during the progress of the work, with estimated costs.

A RAILWAY TO INDIA.

A PLAN FOR A RAILWAY FROM EGYPT TO INDIA TRAVERSING ARABIA AND PERSIA.

C. E. D. Black—The Nineteenth Century.

A PLAN for a railway to connect Egypt and India, traversing Northern Arabia and Southern Persia, is proposed by Mr. C. E. D. Black in *The Nineteenth Century* for January. Mr. Black believes that such a line is a necessity from a political point of view, but he points out that it will not necessarily be a commercial failure. His long experience in the Geographical Department of the India Office has given him exceptional opportunities to study the possibilities of such a railway and some of his comments are interesting.

The western section of the line would start from Port Said or Ismailia, connecting at one of these points with the Egyptian railway system. Thence it would traverse Arabia Petræa in a southeasterly direction to the head of the Gulf of Akabah, and then ascend the Wady el Ithm, one of the lateral gorges leading up to the plateau of northern Arabia. Across the neck of the Arabian peninsula the line would run due east for 800 miles to Barsa, whence a short branch would diverge to Koweit, near the head of the Persian Gulf. At Barsa the railway would cross the Shat-el-Arab and the Karun River farther on. Circling round the head of the Persian Gulf the line would be extended to the Indian frontier by either of two routes, through Shiraz, or more southerly, through Baluchistan as far as Karachi, where it would connect with the Indian railways. The total length of the projected line would be 2200 miles. It could easily be traversed in 66 hours, a saving of 7 days over the sea route from Port Said to Bombay.

The route would traverse a quasi-tropical and, here and there, unproductive country, but it would tap several large and very important oases in northern Arabia from which it would draw considerable traffic. It would also serve as an outlet for the produce of Mesopotamia where irrigation is to be employed on a grand scale. The need of better traffic facilities in Persia has been proclaimed for many years. The trade between the coast and the interior is carried on under almost impossible conditions and the opening of an Indo-Egyptian railway would give an immense impetus to both Persian and Indian commerce in the British sphere of influence.

The passenger traffic would be of much importance. A never-failing stream of officials, military men and merchants continually travels between Great Britain and India and the Far East. To these a saving of a week in time would appeal very strongly. The tourist traffic is attaining considerable dimensions, and a large amount of revenue would be obtained from the pilgrimages of the 60,000,000 Mahometans in India to the holy places of Arabia.

A careful estimate of the cost of the line puts the average cost per mile at £6,000. The experience gained on the Hejaz Railway between Damascus and Medina shows that this estimate is not too low. The total cost would be £13,200,000, or with £3,000,000 added for rolling stock, £16,000,000, an amount considerably less than the cost of the Suez Canal.

In Mr. Black's opinion steps should be taken to obtain a concession without delay. The present relations between Great Britain and the ruling party in Turkey encourage the hope that her good-will would be freely forthcoming and the present circumstances are, he thinks, extraordinarily favorable for the detailed examination of the project as a national undertaking.

THE WEIGHT AND COST OF ELECTRIC GENERATORS.

COMPARATIVE DATA ON THE INFLUENCE OF RATED SPEED AND RATED OUTPUT ON THE WEIGHT AND COST OF ALTERNATING- AND CONTINUOUS-CURRENT DYNAMOS.

A. G. Ellis—Electrical Engineering.

A SERIES of investigations has been made by Mr. A. G. Ellis to obtain more precise information as to the relative weights and costs of alternating- and continuous-current generators, and also as to the influence on these quantities of two of the most important factors in dynamo design, namely, the rated speed and the rated output. A large number of designs have been worked out especially to obtain these data and the results of the investigations, which are contributed by Mr. Ellis to *Electrical Engineering* for December 31, 1908, give probably the most accurate information yet published on the points in question. We reproduce Mr. Ellis' graphical representation of the results and a part of his comment upon them.

The curves are, in the main, self-explanatory. It may be noted that the expression "Total Works Cost" designates the total manufacturing cost of the machine as delivered to the stores, including material and labor costs and establishment charges; the expression "Total Weight" designates the total net weight of the machine as completed, including the shaft and outboard bearing.

Figures 1 to 4 give the data on which the deductions are based. The same range of rated speeds has been taken for both A. C. and C. C. machines. In the case of A. C. generators the rated outputs range from 375 to 6,000 kilowatts. while C. C. dynamos are considered only up to capacities of 1,000 kilowatts. Above this rating, Mr. Ellis says, C. C. dynamos are relatively very unsatisfactory except at pressures of over 1,000 volts. Above 1,500 kilowatts they are impracticable at high speeds. Polyphase alternators, on the other hand, are quite satisfactory and practicable at high

speeds in units of 6,000 kilowatts and even much higher.

In these investigations variations in neither the rated voltage in both types of generators nor the frequency in A. C. machines have been taken into account. Both of these factors, as Mr. Ellis shows, usually influence the design problems and the weight and cost to a considerable extent. In the interests of simplicity, however, the comparisons have been limited to the two principal factors of rated output and speed, representative voltage and frequency being employed for each class of machines. The curves may therefore be taken as fairly representative for machines of normal voltages and periodicities, but in using them it must be borne in mind that although quantitative values of weight and cost are given they cannot have any wide application. Mr. Ellis has attempted to make them as representative as possible but the primary purpose of his investigations was to contrast relative values.

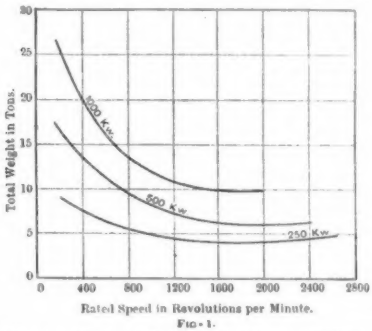


FIG. 1.

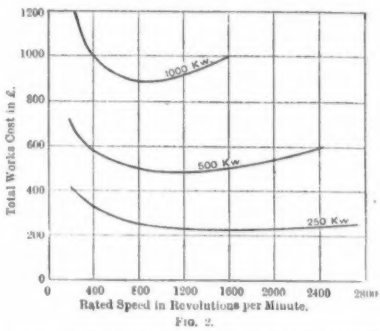


FIG. 2.

FIGS. 1 AND 2. CURVES FOR TOTAL WEIGHT AND TOTAL WORKS COST OF CONTINUOUS-CURRENT GENERATORS.

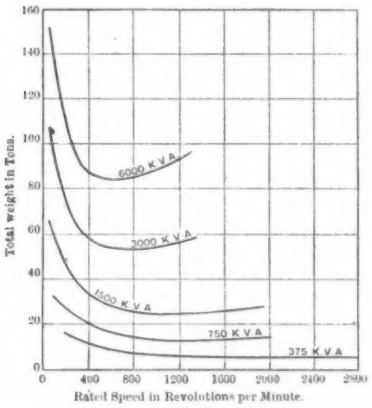


FIG. 3.

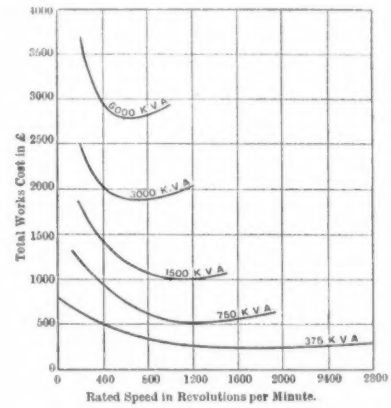


FIG. 4.

FIGS. 3 AND 4. CURVES FOR TOTAL WEIGHT AND TOTAL WORKS COST OF ALTERNATING-CURRENT POLYPHASE GENERATORS.

The simplicity of the basis of comparison has enabled Mr. Ellis to arrive at several broad conclusions which would have remained obscure had it been attempted to take into account too many variables. These he summarizes as follows: "It will be seen from the curves in Figures 1 to 4 that there is a comparatively large range of speed for each rated output, for which the total works

cost has practically a uniform value for A. C. as also for C. C. generators. There is, in fact, a certain rated speed for each rated output, for which the cost has a minimum value. Not only for lower, but also for higher speeds, the cost increases. At low and medium speeds, the weight and cost show a continued decrease with increasing speeds. This is, however, less marked the higher the speed, and is by no means in proportion to the speed.

"These points of minimum weight and cost will be observed for each rated output in the sets of curves in Figures 1 and 2, as also in those of Figures 3 and 4. It will also be noted that the most economical speed is greater the smaller the rated output. Here again, as in C. C. machines, there is a considerable range of speeds over which the weight and cost do not vary to any considerable extent. Even at the lowest speeds, where the effect of the speed is most marked, the variation of weight and cost is by no means in proportion to the change in speed. Thus, for example, a 1,500 kilovolt-amperes A. C. generator at a rated speed of 200 revolutions per minute

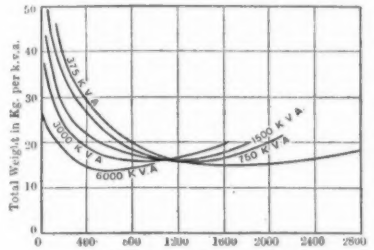


Fig. 5.—Alternating-current Generators.

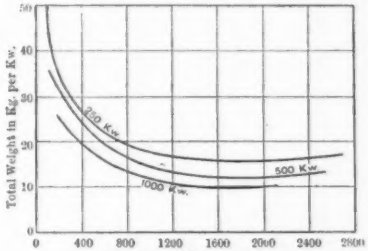


Fig. 7.—Continuous-current Generators.

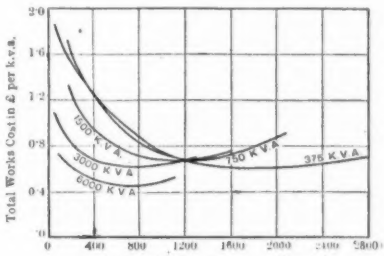


Fig. 6.—Alternating-current Generators.

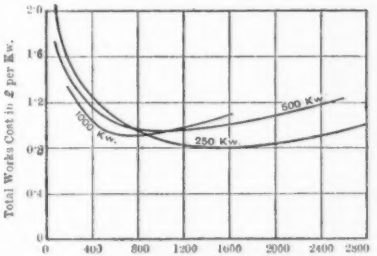


Fig. 8.—Continuous-current Generators.

FIGS. 5 TO 8. CURVES FOR WEIGHT PER KILOWATT AND COST PER KILOWATT FOR ALTERNATING-CURRENT AND CONTINUOUS-CURRENT GENERATORS.

"The speeds shown by the curves in Figures 1 and 2 to be the most economical as far as relates to manufacturing cost, are not the most favourable with regard to performance, their inferiority relating chiefly to commutation. Lower speeds than these, are distinctly to be preferred for continuous-current machines. A similar condition of affairs for A. C. generators is revealed by the curves in Figures 3 and 4. There is, for each rated output, a certain speed at which the weight and cost reach minimum values. These most economical

weighs some 45 tons; at 400 revolutions per minute, which is double this speed, the weight is only reduced to some 33 tons; and a further increase of 100 per cent., viz., to 800 revolutions per minute, only reduces the weight to some 26 tons. The total weight reaches a minimum of 24 tons at 1,000 revolutions per minute, and increases again with increasing speed until at 1,600 revolutions per minute, the weight is again 26 tons, which is actually the same as at half this speed, viz., 800 revolutions per minute. Similar observations may be made for the other rated outputs, and also in regard to the Total Works Cost. For a given rated output in kilovolt-amperes the Total Weight and the Total Works Cost per kilovolt-ampere both decrease as the speed increases until the most economical speed is reached, above which both these quantities increase again. This is shown by the curves in Figures 5 and 6, where are plotted the weight and cost per kilovolt-ampere for A. C. generators. These curves are derived from the curves in Figures 3 and 4. For low and medium speeds the weight and cost per kilovolt-ampere rated output are lower the higher the rated output. It will be seen that the 6,000 kilovolt-ampere curve is the lowest of the group, and that the 375 kilovolt-ampere curve is the highest for speeds up to about 1,000 revolutions per minute. At high speeds, say above 1,000 revolutions per minute, the weight and cost per kilovolt-ampere are higher the greater the rated output. Hence higher speeds are more suitable for machines of small, than for machines of large, rated output. In other words, the larger the rated output the lower is the most economical speed.

"It will be noted further that the weight and cost per kilovolt-ampere at the most economical speed for a machine of 6,000 kilovolt-amperes rated output, are smaller than for a machine of 3,000 kilovolt-amperes rated output. For rated outputs below 3,000 kilovolt-amperes the weight and cost per kilovolt-ampere at the appropriate most economical rated speeds, are of about the same value. Thus the minimum weight per kilovolt-ampere is about 13 kilogrammes, and the cost per kilovolt-ampere some £0.45 (9s.) for a machine of 6,000 kilovolt-amperes rated output as against some 15 kilogrammes and £0.6 (12s.) per kilovolt-ampere for a machine of 3,000 kilovolt-amperes rated output and for ratings below 3,000 kilovolt-amperes. In Figures 7 and 8 are given similar curves for continuous-current machines. The weight and cost per kilowatt are in this case derived from the curves in Figures 1 and 2. These curves are of the same nature as those given in Figures 5 and 6 for alternating-current generators. The weight and cost are, at *low* speeds, influenced to a fairly large extent by the rated speed, but when the region of high speeds is reached the weight and cost are almost independent of the speed. In fact, the cost per kilowatt commences to increase again after a certain speed has been reached, as in the curves for A. C. generators. A point of considerable interest is that while the cost per kilowatt reaches a minimum, and commences to increase considerably again in this manner, the weight per kilowatt does not appreciably increase, but remains at a practically constant value."

A NEW PRODUCT OF THE ELECTRIC FURNACE

A DESCRIPTION OF THE MANUFACTURE, PROPERTIES AND USES OF SILUNDUM.

F. Bölling—Electrochemical and Metallurgical Industry.

EXTENSIVE researches on the use of silicon carbide for electrical resistances to stand high temperatures have resulted in the discovery by Herr F. Bölling, a German engineer, of a process for converting any piece of carbon wholly or partially into silicon carbide. In Herr Bölling's early experiments he attempted to produce resistances by mixing silicon carbide powder with bonds of various compositions to bind the individual crystals together, but

he found that resistances made in this way, though non-conductors at low temperatures became conducting at about 700 to 800 dgrees C. Later, however, it was discovered that if carbon and silicon be heated together out of contact with air to a temperature exceeding 1600 degrees C., the point at which silicon vaporizes, the silicon will penetrate into the carbon, which keeps its shape, and form with it a layer of silicon carbide of any desired thickness. In this way it is possible to produce resistances without binding materials which will stand temperatures as high as 1650 to 1700 degrees C. The silicified carbon obtained by this process, to which the name "silundum" has been given, is now produced commercially in Europe at a plant in Switzerland especially erected for this purpose. Some details of the manufacture, properties and applications of the material are given by Herr Bölling in an article in the *Electrochemical and Metallurgical Industry* for January, 1909, from which we take the following extracts.

"For the production of this material electric furnaces are used, of the same kind as for the manufacture of carborundum. The pieces of carbon of the various shapes are introduced into a mixture of sand and carbon, that is acted upon by a granular core of coke as conductor for the electric current. Instead of sand and carbon, amorphous carborundum can be used, enriched with sand, to provide for the necessary silicon for the carbon pieces to be converted into silundum.

"The silicification of the carbon depends on the time and the temperature employed. It is possible entirely to silicify the carbon pieces or to cover them only with a layer of silundum. This layer may be of any thickness desired. The shape of the carbon article acted upon remains entirely unchanged. It leaves the furnace in the same shape as it was introduced, and manufacturing marks that are pressed on the carbon remain distinctly visible. Tubes of carbon can be silicified inside and outside. Silundum tubes of any thickness of wall and of any diameters, as obtainable from carbon manufactures, are made in silicifying a solid carbon rod, leaving a core of carbon inside, which is burned away in a furnace, which communicates with the air, leaving thus a tube of silundum. It is possible to make round, square or flat tubes.

"If it is desired that one part of the carbon piece remains carbon on one spot, this place is shielded by another piece of carbon, thus preventing the silicon from penetrating into that particular spot. Lamp filaments can be easily converted into silundum or only covered with a layer of silicon carbide. Charcoal is very easily converted into silundum; so is coke, because both these materials are very porous.

"The silicification takes place easier with porous carbon pieces than with pieces that are pressed very hard and tight and baked. Graphite is easily silicified. Carbon powder compressed at very high pressure can be silicified without being baked first. In order to accelerate the process of silicification, the pieces can be made of carbon and amorphous crystalline carborundum, bound together with tar or any other bond that contains carbon. This modification of the regular process of manufacture may be used in cases where very large pieces, bricks or the like, are to be converted into silundum.

"Silundum is another form of silicon carbide and it has generally the same properties. It is very hard; it resists temperatures up to about 1600 degrees C. when heated in air and does not oxidize. It resists the attack of acids when cold and is a conductor of electricity, its resistance being several times that of carbon.

"The hardness of silundum is variable and depends on the zone around the core of the furnace in which it is produced. Material from the amorphous zone is less hard than that obtained in the crystalline zone. It may be assumed that the hardness depends on the temperature in which the material is produced. The hardness may also depend on the amount of silicon taken up by the carbon. It

seems that some pieces contain more or less silicon than others, but no analysis was made to ascertain this.

In regard to the fireproof qualities of silundum, it may be mentioned that at about 1700 degrees C. the silicon leaves the carbon and combines with the oxygen of the air. Small transparent globules are formed (for instance, on a rod that is put in a circuit and heated to about 1700 degrees by the electric current) on the surface, of clear or brownish color. These globules are silicon dioxide. Parts of the silicon escapes in form of a white vapor.

"Silundum cannot be melted, and it behaves in this respect like carbon. The electric resistance of silundum is variable and depends on the kind of carbon and its hardness. Silundum made from porous carbon has a higher resistance than when made of hard carbon. The resistance depends also on the modification of the material. If produced in the amorphous zone the resistance is generally higher than in the crystalline zone.

The first use for which the material found application was for electric cooking and heating purposes. For this use the experiments that led to the invention were made. The electric heating industry for domestic as well as for industrial purposes demands, for a large number of appliances, a higher temperature than can be obtained by ordinary resistance wires. Platinum, of course, can be used, but this material is very expensive, especially so when thick wires or ribbons are used, as should be done, of sufficient mechanical strength. Silundum replaces platinum for this purpose and is much cheaper.

"Electric cooking and heating industries have developed in the last five years enormously and will continue to do so. Any reduction in the price of electric energy will result in a greater demand for electric ranges, which may be used for cooking just like gas ranges. The electric range demands, however, a concentration of electric energy to be converted into heat that can hardly be obtained at present with any system without overheating the resistors or without increasing the weight of the heating plate, with the result that the preparation of a meal requires too much time, in comparison with heating by gas or coal. Silundum stands very high heat, does not oxidize and can be used with the necessary high temperature needed for the purpose. Ranges are produced that have the glowing heat of a coal fire and they are used exactly as those heated by coal.

"For industrial purposes there is a large field for heating apparatus for melting metals, brass, aluminum, lead, tin, etc., and for electric laboratory ovens for high temperatures, and it is especially for this purpose that the material fills a long-felt want. Platinum and platinum-iridium has been used to a great extent for laboratory ovens, but such apparatus are very expensive and they can be repaired only at great expense. Silundum can be used with just as high temperatures as platinum and its price is low. The first cost of the apparatus as well as the expense for repairs are considerably lower than with platinum. For heating purposes the silundum rods can be used single in lengths up to 800 mm, depending, of course, on the diameter, as solid, round, flat or square rods or tubes or made into grids, mounted in a frame and provided with contact wires.

"Silundum stands just as well as silicon carbide the attack of acids, and experiments are now being made to use it as electrodes for electric bleaching purposes instead of platinum-iridium, carbon or graphite. In order to prevent the oxidation of carbon electrodes used for the manufacture of ferrosilicon, it has been proposed to cover these electrodes with a layer of silundum.

"Silundum can be nickel plated or covered with a layer of platinum. It is a very refractory material and does not melt. It is, however, attacked at high temperatures by molten metals, but this should not prevent its use as fireproof material, for it is easily possible to cover the outside of a carbon or graphite crucible or the like with silundum and leave the inside carbon. It is not necessary to silicify pieces to be used for fireproof purposes entirely, but only to a certain

depth and according to the use for which they are to be employed. Carbon bricks or any shaped pieces can be covered with a layer of silundum at small cost. It is thus possible to obtain a material that for many purposes will be far superior to any fireproof material known so far.

"Silicified coke can be used instead of ferrosilicon or carborundum in the steel industries, and, as it can be produced at very low cost, it will doubtless find extended application."

THE PREVENTION OF BOILER SCALE BY ELECTRICITY.

A METHOD OF PRECIPITATING SCALE-FORMING MATERIALS BY THE ACTION OF A LOW-VOLTAGE ELECTRIC CURRENT.

F. A Lart—The Engineering Review.

THE results of some simple experiments recently carried out by Mr. F. A. Lart seem to indicate the possibility of preventing the formation of scale by the passage of a low-voltage electric current through the water in a working boiler. The investigations have not been carried far enough to permit the accumulation of any exact quantitative or qualitative data, but, to Mr. Lart at least, the results have been sufficiently practical and conclusive to prove his theories and the deductions immediately involved. A paper outlining his conclusions, originally published in *The Engineering Review*, is abstracted in *The Railway and Engineering Review* for January 23, from which we take the following paragraphs:

"It is not generally known to engineers that the process of converting water into steam in a boiler sets up or is accompanied by distinct electric currents in the water and in the structure of the boiler, or that by passing such a current of electricity through the water in a boiler during the conversion of it into steam, or through any static volume of cold or only warm or moderately heated water such as may be contained in a tank or other receptacle, the deposition of solid matter in mechanical suspension or, in certain cases, in chemical solution in the water, can thereby be effected.

"The electric current induced in the former case is probably of galvanic or voltaic origin, due to the water forming an electro-chemical couple between the different materials or metals of which the boiler is constructed—that is, the steel or iron shell and the copper or copper-alloy fire-box or tubes; or, it may be, through the purely voltaic coupling of the metallic elements comprising the boiler structure, where they are dissimilar or where the boiler is constructed wholly of steel or iron plates and tubes, as is frequently the case, which are possessed of unequal electrical potentialities.

"It is, however, very unusual for any boiler nominally constructed wholly of steel or iron not to carry in some part of it one or more small detail parts made of copper or some alloy of copper, which parts are in direct and regular contact with the water and the steel or iron shell simultaneously. The presence of these materials and metals in close conjunction with the steel or iron of the main structure of the boiler, and both in contact with the water and therefore additionally and most effectively coupled to one another, is sufficient to form, especially if, as is usually the case, the water is possessed of any acidity, an electro-chemical or galvanic couple equivalent to a primary battery, from which proceeds in due order and inevitably an electric current which permeates and affects the entire structure of the boiler and the entire volume of the water contained in it. This electro-chemical action exists under these circumstances with static, cold water as well as in the hot and constantly fluent water of a working boiler. In the latter case the action takes place much more markedly, of course, since such action is always assisted in a great degree by heat.

"It is suggested, therefore, that the prevention or the mitigation of the action of scale-formation in boilers through rendering the usually more or less acid water alkaline or neutral by some special process, such as the adding to it of lime, is as much due to the resulting impossibility of electro-chemical action between the water and the metallic elements with which it is in intimate contact as to the total prohibition under these circumstances of the purely chemical dissolution of the scale-forming elements contained in the water."

Mr. Lart believes that this electro-chemical or purely electrical theory is the true explanation of the whole question of scale formation and its prevention. Minute electric currents, he says, can always be detected by a galvanometer connected between the water in a working boiler and the metallic shell, or between two distant but connected parts of the boiler.

"But it has been found, through some experiments recently conducted—that by passing an electric current of very moderate potential, as from any ordinary dry or wet electro-chemical primary battery, through the structure of a working boiler via the water contained in it and in process of conversion into steam, the formation of scale on the heating and general internal water-covered surfaces of the boiler may be entirely prevented, the deposition of the solid matters contained in the water in mechanical suspension and the precipitation of these in chemical solution being accelerated, the resulting deposit or precipitate being simply loose particles or mud of the lime or magnesia or other impurities contained in the natural water.

"So also, though with more difficulty so far as the experiments were conducted, in the case of static, cold water or water only moderately heated or heated up to boiling point and not subject to the violent disturbance or evolution of the carbonic acid gas contained in it, or raised to the intense heat and consequent internal molecular strain and disruption which accompany the formation of steam at any considerable pressure under the ordinary conditions of boiler working. Mr. Lart has not experimented with any electric current of high intensity or quantity, as from a dynamo or power storage cell, and cannot, therefore, state anything as to the effect of such currents in the directions indicated. The experiments were made with a dry cell of 1.5 volts. Possibly it may be found that the most suitable current for these purposes of water purification and scale prevention would be one of low potential and high quantity as in the ordinary commercial process of electro-plating."

The beneficial effect of zinc in preventing scale-formation is due, according to Mr. Lart, to some sort of electro-chemical action. He finds additional confirmation of his theory in the facts that scale does not form in vessels formed solely of non-ferrous metals or in iron vessels lined with non-conducting enamels, and that analyses of boiler scale always show appreciable quantities of ferric oxide. From the latter fact he infers that the iron or steel of the boiler shell forms the positive pole of the battery from which the electric currents in the boiler proceed.

Carbonates of lime and magnesia are readily precipitated by moderate heating; the sulphates, however, cannot be so easily eliminated. "But both in the case of the carbonates and of the sulphates of lime and magnesia, as well as of lime and chalk in purely mechanical suspension or 'solution' in the water, the writer's experiments clearly demonstrated that whether with cold, or hot, or boiling water the deposition and precipitation referred to are much facilitated by passing an electric current of very moderate e. m. f. through the water.

"In each case the deposit occurs as a finely divided and slightly curded or flocculent powder or mud, and not as a coagulated mass or concreted scale. In this fact lies the primary importance of this method of electro-purification of boiler water and scale prevention, because, though, of course, not at all desirable, the presence of a muddy, loose de-

posit at the bottom of a boiler barrel or fire-box water-space is not at all harmful to the boiler or obstructive to its evaporation and steam-raising duties, provided it is not allowed to accumulate to excess, of course; and is in any case infinitely preferable to the formation of congealed deposit or concreted and fast-adhering scale upon every inch of interior surface covered by the water.

"In applying this electrical method of water purification and scale prevention to steam boilers, the writer would suggest connecting the top and bottom, the sides, and the ends, respectively, each and all, or such as the construction of the boiler may provide, well below the normal water-level, with one or more primary batteries or other convenient electric current supply, so that there would be a continuous electric current passing through the whole body of the water in the boiler longitudinally, transversely, and vertically, as far as possible, and thoroughly permeating it throughout. This would be very easily and simply effected by attaching the wires from the batteries or other current source to brass plugs tapped into the boiler shell, and in every case projecting well into the water and always covered by it."

BEARING METALS.

A SUMMARY OF THE QUALITIES REQUIRED IN BEARING METALS AND THE PROPERTIES OF THE PRINCIPAL CLASSES OF ANTI-FRICTION ALLOYS.

A. H. Hiorns—Birmingham Association of Mechanical Engineers.

AN unusually interesting treatment of the subject of anti-friction alloys for bearing metals is given in a paper read by Mr. A. H. Hiorns at a recent meeting of the Birmingham Association of Mechanical Engineers. A review is given of the qualities required in bearing metals and an attempt is made to give a methodical classification and description of the properties of the main classes of anti-friction alloys now in use, based upon the latest and most authentic information. We abstract Mr. Hiorns' paper from a reprint in *The Mechanical Engineer* for December 25, 1908.

Charpy states that in a well adjusted journal the friction is practically the same regardless of the metal in contact, and depends exclusively on the lubricant; a layer of oil remains constantly between the journal and the bearing and the only friction is between a solid and a liquid. Accurate adjustment and perfect lubrication of bearings are, however, ideal conditions usually impossible of attainment in practice and the nature of the bearing metal is a determining factor in the modification or prevention of such troubles as hot boxes and cuttings.

As long ago as 1820, Rennie studied the friction between two bodies kept in contact by gradually increasing pressure. He found that in the case of small loads the coefficient of friction at the start is practically constant, that the friction increases nearly proportional to the pressure, and that above a certain load the coefficient of friction increases rapidly, the surfaces in contact rub against each other, become heated, and finally cut, which corresponds to an abrupt and very great increase in the coefficient of friction. The load at which rubbing begins is generally greater the harder the metals in contact; on the other hand the coefficient of friction is generally smaller the harder the metals. Hence in order both to reduce friction and to avoid cutting, hard substances should be used for bearing surfaces.

The use of hard substances, however, corrects only the effects of defective lubrication; it is no remedy for imperfect adjustment. In practice the load on a bearing is not uniformly distributed but is concentrated at certain points. If the metal is hard and unyielding, the pressure on these points becomes considerable and leads to heating and cutting. Hence the bearing must have a certain plasticity so as to mould itself round the

shaft and increase the surface of contact, and, as the bearing gradually wears away, constantly to restore its contact with the shaft.

These two seemingly contradictory characteristics of hardness and plasticity are secured by employing for bearing metals certain alloys composed of hard grains imbedded in a plastic matrix. This is the main principle aimed at in anti-friction alloys. Plasticity, as well as brittleness, is determined by a compression test. The composition of the alloy is of prime importance since on it the structure depends. The structure may be altered by heat treatment. Under the conditions in which a bearing is used, this alteration is negligible, but serious defects in the bearing may be produced by improper heating before casting.

These defects may be summarized as segregation, coarse crystalline structure, oxidation products and enclosed gases. Segregation is often due to improper proportioning of the constituents of the alloy and the application of excessive heat. It may be more or less prevented by quick cooling but the metal then loses ductility. Coarse crystalline structure is the result of pouring at too high temperature but it may also be due to the use of an excess of deoxidizing agents or to the presence of impurities. The other faults are the result of carelessness in casting.

Friction in a bearing depends on the structure and composition of the alloy. Hard metals have a lower coefficient of friction than soft metals but they are more liable to heating on account of their lack of plasticity. An unyielding metal causes concentration of the load on a few projecting parts, resulting in abnormal pressure on these points which leads to abrasion and heating. The use of copper-tin alloys for heavy loads and high speeds used to be common, on account of their hardness and low coefficient of friction, but they have been superseded by the lead-lined bearing which is now widely used.

The composition of the bearing has a decided effect on the life of the journal. It is generally considered that a soft bearing causes a marked decrease in the journal's life, though the reason is not altogether clear. One authority says that driving axles have a tendency to wear tapering and hollow on account of the uneven distribution of dirt in the packing. But uneven wear is caused by the use of babbitt strips above the bearing surface, and the tendency to wear hollow has been traced to this cause.

A test of the compressive strength of bearing alloys is of importance, for the alloy must be hard enough to support the load without deformation. If it is too brittle it will crack under pressure. If it is sufficiently plastic it will keep cool even under exceptional circumstances. It has been found that tension tests also give valuable information as to the properties of bearing alloys; the higher the tensile strength and elongation, the longer the life of the bearing.

The essential points to be considered in a bearing metal are composition, structure, friction, temperature of running, wear on bearing, wear on journal, compressive strength and cost. No one alloy will reach perfection in all these requirements. The combinations must be studied in detail and the qualifications of each alloy balanced against those of the others according to the special features required. The main properties of the principal classes of alloys used for bearing metals are given in very brief summary.

Lead and antimony alloy in all proportions. The higher the percentage of antimony the more hard and brittle is the alloy. The eutectic contains 13 per cent. antimony. With less than this amount the alloy consists of crystals of lead and eutectic; with more than 13 per cent., of crystals of antimony and eutectic. Above 13 per cent. antimony, therefore, the alloy consists of hard grains in a plastic matrix and fulfils this requirement of an anti-friction alloy. Alloys containing 15 to 20 per cent. antimony are the most suitable, though for light pressures the eutectic alloy is advantageous, the greatly diminished wear offsetting the higher friction. The 13 per

cent. alloy has been adopted by the Pennsylvania Railroad as the best all-round bearing metal for railway work. The compressive strength of lead-antimony alloys rises rapidly with increasing proportion of antimony, except between 14 and 30 per cent. when the compressive strength is practically the same as that of the eutectic. When the load reaches a certain limit, however, the crystals of antimony, having no plasticity, break, and the alloy is reduced to fragments.

Lead-tin-bismuth alloys are mentioned only in passing. Of the tin-antimony-copper alloys, or Babbitt metals, the alloy containing 83 per cent. tin, 11½ per cent. copper and 5½ per cent. antimony has been found by Charpy to possess the greatest compressive strength. Alloys for bearings should be within at least 3 or 4 per cent. of this composition.

Ternary alloys of lead, tin and antimony are superior to the binary alloys of lead and antimony, though they have a similar composition. The tin intervenes as a constituent of the hard grains, diminishing their hardness but also their brittleness. Tin also enters the eutectic, increasing its compressive strength. The tin must exceed 10 per cent. but not necessarily 20 per cent.; antimony may vary between 10 and 16 per cent. An alloy with 76 per cent. lead, 14 tin and 10 antimony shows comparatively few hard grains. If the proportion of antimony is reduced the grains disappear. An alloy with 80 per cent. lead, 12 tin, and 8 antimony is used on the Eastern Railway of France as a packing for piston rods. When the proportion of antimony is increased the hard grains become more numerous; an alloy containing 70 per cent. lead, 10 tin and 20 antimony is used for packing for excentric collars.

Lead-copper-antimony alloys are also used. One particular alloy, containing 65 per cent. lead, 25 antimony and 10 copper is employed for packing for locomotives and tenders

There seems to be no ternary compound of zinc, tin and antimony in alloys in which zinc predominates. They are probably formed of zinc, tin and antimonide of zinc, and the alloys may be divided into three groups according to the constituent which crystallizes first. The alloy in which the zinc antimonide is the first to crystallize is the only one suitable for anti-friction purposes. Alloys with excess of zinc have a very high compressive strength, but, though tin diminishes the brittleness of zinc-antimony alloys, they are very liable to brittleness when heated. They cannot be recommended for bearings and are little used except where low price is esteemed.

Bronzes, largely used for bearings may be classed under two heads: alloys of copper and tin with only small quantities of other metals, such as phosphorus, zinc, etc.; and alloys of copper, tin and lead. The compressive strength of the yellow copper-tin alloys is greater than that of the white alloys, and it increases regularly with the proportion of tin. Phosphorus seems to have no marked influence on the compressive strength. Until the proportion of tin reaches 20 per cent, the copper-tin alloys have a uniform structure, a eutectic matrix of copper and Cu_3Sn containing crystalline needles of copper. Phosphorus when present enters the matrix, modifying its hardness. The eutectic is much stronger than pure copper; on it the compressive strength of the mass depends. The addition of lead increases the plasticity.

Copper-tin-lead alloy is now the chief of the standard bearing bronzes. The addition of lead to the copper-tin makes the alloy less liable to heat under the same lubrication and diminishes the rate of wear. Tests by Dr. Dudley have shown that phosphorus and arsenic exercise no marked influence on wear, that the metal which wears least is capable of undergoing the greatest distortion before breaking, and that the rate of wear decreases with increase of lead. Clamer claims the best alloy for general purposes to be copper 64 per cent., tin 5, lead 30, and nickel 1. Bronzes containing zinc are cheap but zinc increases the rate of wear and has a tendency to segregate lead.

The constitution of bronzes is the reverse of that of white alloys. Instead of

hard grains in a plastic eutectic, they have soft grains in a hard eutectic for the same degree of plasticity. Bronzes are inferior to white metals because they are less plastic and do not mould themselves as well around the axle. Their greater strength does not permit a heavier load, for then the lubrication is interfered with and the bearing tends to become heated. Also on account of their constitution bronzes have a greater tendency than white alloys to cut.

In conclusion, "an anti-friction alloy should have hard grains in a plastic matrix, then the load is carried by the hard grains which have a low coefficient of friction, and the cutting can only take place with difficulty. The plasticity of the cement makes it possible for the bearing to adjust itself round the shaft, thus avoiding local pressures, which are the chief cause of accidents. Such properties may be obtained in binary alloys with such metals as antimony, tin, and copper, which form chemical compounds. The requisite properties are better obtained in ternary alloys, which give a good plastic matrix (eutectic). To test an anti-friction alloy, compression tests and the microscope are invaluable aids.

RECENT PROGRESS IN EXPLOSIVES.

A SUMMARY OF THE MORE IMPORTANT ADVANCES IN EXPLOSIVES FOR MINING WORK DURING THE LAST TWENTY YEARS.

Oscar Guttmann—Royal Society of Arts.

EXPLOSIVES formed the subject of the four lectures of the first series of Cantor Lectures delivered before the Royal Society of Arts in November and December last. The lectures, which were delivered by Mr. Oscar Guttmann, long known as an authority on the subject, are printed in full in the *Journal* of the Society for December 25, 1908, *et seq.* Mr. Guttmann covered in broad review the progress in the whole field of blasting and military explosives during the last twenty years and the improvements in methods of manufacture and of testing. We give below in brief outline a few of his interesting comments on explosives adapted to mining work.

Though the last twenty years have seen quite as important progress in explosives as the whole of the previous years, the use of the old black powder shows little sign of dying out. In Great Britain more than half the total weight of explosives used in 1907 consisted of black powder. Practically no progress has been made in this blasting agent since 1886 but a number of rough mixtures similar to black powder have been revived and are used extensively in Germany. Among these may be mentioned "Sprengsalpeter," practically a black powder with sodium nitrate instead of potassium nitrate, "Petroklastite" containing coal pitch and bichromate, and "Cahücite," a mixture of potassium nitrate, sulphur, lamp black, cellulose, and iron sulphate. In America large quantities of sodium nitrate powders are used.

There has been no special improvement in dynamite since blasting gelatine was invented in 1875. This explosive and the gelatine dynamites have in most countries driven "Kieselguhr" dynamite out of the field. Considerable advance, however, has been made in the removal of one of the chief objections to dynamite, its liability to freezing. The addition of nitrobenzine to nitroglycerine was one of the first expedients tried but it was found that the presence of the nitrobenzine reduced the explosive power when used in sufficient quantities to prevent freezing. Later dinitrotoluene was used, and in 1904 the addition of dinitroglycerine to trinitroglycerine explosives was patented, together with a practical method of manufacturing dinitroglycerine. The latter is now made on a large scale in Germany. A large number of other additions have been tried but none has been definitely adopted for the manufacture of unfreezable dynamites. Lately dinitrodichlorhydrine has been used with considerable success.

Perhaps the main advance in explosives during the last two decades has been in the field of safety explosives for gaseous collieries. A large part of this advance has been due to the use of ammonium nitrate as an ingredient in a powder mixture. It has been definitely established that ammonium nitrate is absolutely safe in all quantities. It cannot be used alone but it simply remains to be determined what minimum quantity of combustible can be added to avoid flames of great length and duration. The Wetter-Dynammon made by the Austrian Government for use in fiery mines contains ammonium nitrate, 93.83 per cent., potassium nitrate, 1.98 per cent., charcoal, 3.77 per cent., and 0.42 per cent. of moisture.

Explosives containing potassium chlorate were for long excluded from the list of safety explosives on account of their extreme liability to explode under impact or friction. The recent advent of electrolytic methods for the manufacture of potassium chlorate has brought the price of this chemical down to a point where it can be used commercially in the manufacture of suitable explosives and a great deal of research has been applied to the investigation of methods of eliminating its dangerous qualities. Success has been attained by the addition to the explosive of some oil. Cheddite, the first practical chlorate explosive, contains 80 parts of potassium chlorate, 13 parts of mononitronaphthalene, 2 parts of dinitrotoluene, and 5 parts of castor oil. In 1908 a chlorate explosive was licensed as a safety explosive in England under the name of "Colliery Steelite." It consists of 74 parts of potassium chlorate, 25 parts of oxidized resin and one part of castor oil.

The first real safety explosive was a nitroglycerine explosive, Carbonite. Curiously enough it has not been surpassed for safety, though it has been on the market for twenty years. The composition is saltpeter, cellulose, nitroglycerine and sulphuretted oil. The investigation of nitroglycerine safety explosives has shown that the addition of cellulose to nitroglycerine compositions, as rye flour to Carbonite or wood pulp to other explosives, renders them highly inert in fire-damp mixtures.

In every European country the use of gunpowder is prohibited in fiery mines. One black powder-like mixture, Bobbinite, however, has passed even the most stringent tests in England and has been admitted to the list of permitted explosives. It consists of about 64 parts of potassium nitrate, 2 parts of sulphur, and 19 parts of charcoal, with the addition of 15 parts of a mixture of ammonium and copper sulphates, or alternatively of eight parts of starch and three parts of paraffin wax with a corresponding increase in the other materials. As will be seen from the table below, over a million pounds were used in Great Britain in 1907. It has the advantage of being slow-burning and of not unduly shattering the coal. The facts that the miners are used to black powder, and that of the bore-hole be overcharged as usual, Bobbinite does not break up the coal badly, have also assisted in making it popular.

"Lacking definite information as to what really renders an explosive safe in fire damp and how this is to be ascertained it is natural to seek a solution in practical results. It is not unfair to assume that the statistics showing the quantities of safety explosives actually consumed in a great coal-producing country like Great Britain have a real bearing on the question as to which explosives have given a reasonable amount of safety. The report of the Inspectors of Explosives for 1907 give the following highly instructive table.

"Out of a total consumption of 7,764,122 pounds were used:

Explosive.	Quantity used, pounds.	Percentage of total.
Saxonite	1,721,193	22.18
Bobbinite	1,063,111	13.69
Monobel Powder	711,691	9.17
Ammonite	562,405	7.25
Carbonite	551,948	7.11
Roburite	510.438	6.57
Arkite	437,780	5.64
Westfalite	405,691	5.22
Bellite	371,455	4.78
Rippite	306,408	3.95
Faversham Powder	224,200	2.88
Stowite	180,393	2.32
Ammonal	114,806	1.48

Of these Saxonite, Monobel Powder,

Carbonite, Arkite, Rippite, and Stowite contain large percentages of nitroglycerine. Bobbinite is a black powder mixture. The rest are ammonium nitrate explosives.

"It will thus be seen that a black powder mixture like Bobbinite, which would not be licensed in any other country and would be condemned without trial, ranks second in consumption, being used to the extent of 13.7 per cent. of the total consumption; whilst Saxonite, a nitroglycerine explosive, ranks first with 22.18 per cent. of the total." It is perhaps safe to conclude that the use of explosives has been made infinitely less dangerous than before without the reason for the increased safety being fully known.

THE WORK OF SUPERHEATER AND COMPOUND LOCOMOTIVES.

A COMPARISON OF RESULTS OBTAINED IN EUROPEAN PRACTICE.

Charles R. King—The Engineer.

WE reviewed in these columns some months ago a series of articles by Dr. Wilhelm Schmidt on the economy of superheating in locomotives. In Dr. Schmidt's opinion the engine of the future will be of the four-cylinder simple type using highly superheated steam and working at a moderate boiler pressure. Mr. Charles R. King who contributed to this magazine last year a series of articles on recent European locomotive practice, compares in *The Engineer* for December 25, 1908, recent authentic operating results of superheater and compound locomotives on various European railways, which show uniformly in the compound saturated-steam types a large fuel economy over superheater locomotives. Mr. King is an enthusiastic advocate of the compound locomotive and a few of his comparative data and comments may be of interest.

Mr. King gives an interesting series of charts comparing results obtained with superheater locomotives on the Prussian State Railways with those obtained with compounds in Italy. The charts combine in a single diagram information as to the railway profile, train speeds and loads hauled. The speeds are scaled above the profile and the loads above the speed line; the resulting line shows the relative values of work done on ascending and descending gradients. The records on the Prussian railways have repeatedly been claimed to be "brilliant results showing the enormous capabilities of the method"; they are expressly stated to be "ideal maxima" resulting from special trials under exceptionally favorable conditions of running. The compound-locomotive records are those of comparatively old engines in actual service in Italy. They are not intended to represent the maximum for compound locomotives but are chosen for comparison because they are records of trips comparable for gradient and length of run with those of the superheater locomotives.

Without going into Mr. King's lengthy discussion of these charts, it may be said that they show uniformly a superiority on the part of the compound locomotive. One of the charts compares the results of trials of a superheater engine weighing 61 tons and hauling a car load of 353 tons with compound-locomotive results obtained in regular express service between Milan and Venice, over a more difficult section of line. The weight of the compound was 60.5 tons and that of its car load 413 tons. Notwithstanding the important difference in conditions between a prepared trial run and ordinary every-day traffic, it showed a coal consumption of 24.4 kilogrammes per 1,000 ton-kilometres as against a consumption of 27 kilometres by the superheater locomotive. In a still more striking case, cited by Mr. King, a compound locomotive in service between Florence and Laterina made a coal-consumption record of 5.24 kilogrammes per 100 ton-kilometres under conditions comparable with, but more difficult than, those which

obtained in a test of a superheater locomotive on the Prussian railways when a coal consumption of 10 kilogrammes per 100 ton-kilometres was recorded.

But, says Mr. King, "it is perhaps unfair to contrast superheater locomotives with compound engines. It is not usual —or has not been hitherto—to show the saving of fuel in compound engines as compared with superheater locomotives, but only as compared with single expansion saturated engines." He gives therefore a number of data on the economy of compound over single expansion engines, taken for the most part from the quarterly coal reports of the Italian compounds. Over single-expansion engines of three classes a recent type of compound shows fuel savings, on the basis of coal consumption per 100 ton-kilometres, amounting to 36, 34 and 28 per cent respectively. In freight engines with slow piston speeds and for mountain service the saving in coal is about 18 per cent. Four-cylinder balanced compounds show a saving in mountain and freight service of 22 per cent. over single-expansion engines, and in express service of 35 per cent. The latter figure is the average of a long period of service in different locomotive divisions in Italy during the first few years of the use of the "Adriatic" type locomotives. That this economy is still apparent is shown in a recent report by the chief engineer of the testing department of the State Railways. The report states that during the five years they have been in service the compound engines have hauled loads 60 per cent. heavier, with a fuel consumption only 5 per cent. greater, than the single-expansion locomotives.

"In all countries of the Continent—Prussia, South Germany, Austria, France, and Belgium—the gain by double expansion is a most important one, and without involving any extra complication that does not exist in single expansion engines having the same number of cylinders; the number of engine parts being precisely the same in both cases, since a two-cylinder compound engine without starting valve differs in no way from so-called 'simple' engines except in the different diameters of the two cylinders.

"With superheater engines a very complicated and very costly boiler is necessary. Austrian engines fitted with Schmidt apparatus cost £340 per engine extra and the royalties are an additional expense. The weight of engines in some instances becomes two tons heavier in boilers for the same steam pressures." In Belgium where special classes of engines were built for the purpose of comparing the superheating and compounding systems it is admitted that "it has been recognized in current service that the four-cylinder non-compound engine is less economical than the compounds."

In France an impartial trial of superheating showed an American engine with superheater to be 16 per cent. more economical than the same engine without superheater, but a compound engine of the same class showed a saving of 24 per cent. over the saturated simple engine. "It is obvious," Mr. King says, "that the best results credited to superheaters occur when saturated steam boilers are either designed in such manner, or worked in such manner, as to cause abundant priming, and when such defective conditions are compared with carefully worked superheater locomotives." On the Nord Railway the saving of the compounds is over 17 per cent. The Nord engineers report that the results "show that the compound system is economical at moderate pressures, 147 pounds, and that, in consequence, its advantages have not as a condition the use of high pressures."

"Fuel economy by means of compounding at low pressures has been the common result of practice for twenty years past. The mechanical means of compounding are very simple. If a large boilered superheater engine is to be converted to compound working, the superheater tubes are withdrawn and replaced by ordinary tubes, the gain in heating surface largely compensating for the removal of the superheater. The various accessories are also cleared away and one of the large cylinders replaced by another of smaller bore, so reducing en-

gine weight and diminishing the surface of cylinder walls and the heat losses due to their greater heat radiation. If it is a small-boilered saturated engine to convert, the usual process is to fit one larger cylinder. In either case the number of moving parts in the engine motion and valve gear remains unchanged. The simple outcome of the changed method of working will vary from 10 to 35 per cent. fuel saving, according to the individual skill of the designer, all other things being equal. These examples make clear the fact that there is no complication in compounding, the list of parts for either single or double-expansion engines being the same in each type, although cases exist where the simple engines have more working parts than compounds.

"As there is no mechanical complication in the compounds it may be averred that the two-stage expansion is in itself a complication. But this complication in the movement of the steam itself results in up to 36 per cent. economy—a decided advantage. Again, it will be urged that compounds cannot start quickly. The reply to this is to be found in an examination of the acceleration curves of the compound locomotives in our diagrams—further remark is superfluous. It is sometimes asserted that compounds are heavier, more costly to build, and dearer to keep in repair. As to the weight, compound engines are built which do not weight ¼ ton more than sister-built non-compounds with the same boiler pressure. Take, for instance, goods engines Classes '1002' to '1005' Eastern of France Railways. Of the same weight and built in the same lot their price per pound is the same, but the compounds save so much coal, that, after a period of fifteen years' very rough service it is still necessary with the engines mentioned to keep their coal lists separate, the latest annual returns—1907—still showing 14 per cent. coal economy, and the enginemen of the compounds gaining less in coal premiums because of the higher coal saving capacity of the compounds. Both simple and compound engines have the same number of working parts. If the compounds were to be converted for single expansion there would be no saving in weight in number of parts, in boiler pressure, or in simplicity; there would be at once increase of coal consumption by over 14 per cent.

"Of the more costly maintenance of compounds an excellent authority has already shown in *The Engineer* that on the Prussian State Railways, under his control, single-expansion engines only run 23,500 miles between consecutive repairs, while compound engines run 29,440 miles between consecutive repairs, these being the averages of ten locomotives during about eleven years of service. The greater approximation of the average piston effort to the maximum piston effort is the principal saving in wear and breakage with any form of compound motor; and the fact that, in the cylinder of compound engines which is subject to the highest pressure, the piston rings may be used longer without the same steam losses by leakage, and that the piston rings of the low-pressure cylinders are not subject to such heavy pressures as in single-expansion engines is a very simple reason why compound engines should be, as they have been proved to be, less costly in repairs.

"In conclusion, it is to be noted that though superheated steam boilers give neither the economy in coal nor introduce any mechanical advantages such as are realized every day in the service of compound engines, it by no means follows that superheater boilers are not advantageous applied to any form of motor—compound or non-compound. The experience of 140 years has demonstrated the utility of the superheater, whilst it has also shown that superheaters introduce risks of breakdown of considerable gravity, and exact unremitting care and attention, or otherwise become inefficient. On the contrary, double-expansion engines are much more flexible under variations of boiler pressure, and the mere decreasing or increasing of the diameter of one cylinder in a pair involves no such constructive complication as do boilers with superheaters."

THE ENGINEERING INDEX

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The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Bascule.

Bascule Bridge on the C. & A. Illustrates and describes the Page bascule bridge on the Chicago & Alton, and its working. 800 w. Ry & Loc Engng—Jan., 1909. No. 1446 C.

Blackwell's Island.

The Footwalks of the Blackwell's Island Bridge. F. W. Abbott, and J. P. H. Perry. Outlines the design of these footwalks and describes their construction. Ills. 6000 w. Eng News—Jan. 28, 1909. No. 2150.

End-Launching.

Bridge Erection by the End-Launching Method (Lançage des Ponts au Moyen de Chalands). Ch. Dantin. Describes the work of erecting the Kyrönsalmi-Sund bridge in Finland and the French River bridge in Canada. Ills. 1600 w. Génie Civil—Dec. 5, 1908. No. 1925 D.

Footwalks.

See Blackwell's Island, under BRIDGES.

Plate Girders.

Plate Girder Web Splices. C. R. Young. Discusses the design of web splices, criticizing various arrangements. Ills. 4500 w. Ap Sci—Jan., 1909. No. 2093 C.

We supply copies of these articles. See page 1071.

Reinforced Concrete.

Cost of Concrete Bridges. Henry H. Quimby. Read before the Nat. Assn. of Cement Users. General discussion of first cost and maintenance cost as compared with steel. 1500 w. Eng Rec—Jan. 23, 1909. No. 2026.

Cost Account of Seine River Bridge, St. Boniface. Estimate of cost for a reinforced concrete bridge in Manitoba. 1500 w. Can Engr—Jan. 15, 1909. No. 1773.

The Rocky River Concrete Bridge Near Cleveland, O. Illustrates and describes a reinforced-concrete viaduct with a central arch having a clear span of 280 ft. 2500 w. Eng Rec—Jan. 23, 1909. No. 2020.

A Bridge Over the Oberspree Near Berlin (Die Stubenrauch-Brücke über die Oberspree bei Berlin). Karl Bernhard. Illustrated description of a bridge having two reinforced-concrete spans and one steel span. Serial, 1st part. 5000 w. Zeitschr d Ver Deutscher Ing—Dec. 5, 1908. No. 1997 D.

Calculation of the Reinforced-Concrete Bridge Over the Amper at Esting (Statische Berechnung der Eisenbetonbalkenbrücke bei Esting an der Amper). Hans Popp. A mathematical paper describing the designing a bridge of three spans, each 12.84 metres long. Ills. 2800 w. Beton u Eisen—Dec. 14, 1908. No. 1985 F.

See also Steel, and Trestles, under BRIDGES.

Removal.

Removal of Madison Avenue Drawbridge, New York City. George H. Hefele. Illustrates and describes the successful removal of the draw-span from the old bridge to the temporary structure. 1800 w. Eng News—Dec. 31, 1908. No. 1404.

Steel.

Rio Conchos Bridge of the Kansas City, Mexico & Orient. W. W. Colpitts. Illustrated description of a bridge of 17 spans of 50 ft. deck-plate girders, supported on plain concrete piers and reinforced concrete abutments. 2800 w. R R Age Gaz—Jan. 22, 1909. No. 2001.

The New Bridge Crossing the Mississippi River at Clinton, Ia.; Chicago & Northwestern Ry. F. H. Bainbridge. Gives the history of earlier bridges at this point, and illustrated detailed description of the new structure. 7000 w. Eng News—Jan. 21, 1909. No. 1874.

See also Plate Girders, and Reinforced Concrete, under BRIDGES.

Trestles.

Ferro-Concrete Coal Tip and Viaduct at Sharpness Docks. Reviews the history of these docks, illustrating and describing recent improvements. 1500 w. Engr, Lond—Jan. 15, 1909. No. 2084A.

Viaducts.

The Pleasant Run Bridge of the Cincinnati, New Orleans and Texas Pacific Railway. Illustrated description of a new steel structure in Kentucky. 1500 w. Eng Rec—Jan. 9, 1909. No. 1572.

The Cuyahoga Viaduct of the New York, Chicago & St. Louis Railroad. A double track steel bridge of Cleveland, O., having a length of about 3,010½ ft. crossing a river, several streets and a number of tracks. 2000 w. Eng Rec—Jan. 9, 1909. No. 1574.

CONSTRUCTION.

Concrete.

Method of Finishing Concrete Surfaces by Scrubbing Followed by an Acid Wash, With an Estimate of Cost. Views and description with cost analysis. 1500 w. Engng-Con—Jan. 6, 1909. No. 1588.

The Bonding of New to Old Concrete. E. P. Goodrich. Reviews the experimental work in this field, and gives an account of investigations made by the author. Ills. 8500 w. Pro Am Soc of Civ Engrs—Jan., 1909. No. 2123 E.

Concrete Blocks.

The "Eternit" Artificial Stone (La Pietra "Eternit"). Their constituents, making and use are described. Ills. 3500 w. Il Cemento—Nov., 1908. No. 1936 D.

Cost-Keeping.

Cost Keeping on Municipal Contract Work. De Witt V. Moore. Discusses the methods of cost keeping and the benefit. 2500 w. Munic Engng—Jan., 1909. No. 1738 C.

Cost-Keeping on Concrete Construction on the C. B. & Q. Don E. Mowry. Brief explanation of method used. 900 w. R R Age Gaz—Jan. 15, 1909. No. 1794.

A System of Collecting Cost Data With Particular Reference to a Sewer Contract. Explains the system used by two associated companies at Indianapolis, Ind. 2000 w. Engng-Con—Jan. 13, 1909. No. 1784.

Excavation.

Comments on Handling Earth with Wheelbarrows. Discusses their economic limitations. 1200 w. Engng-Con—Dec. 30, 1908. No. 1453.

Methods and Costs of Rock Excavation and Washing Gravel for a Concrete Dam. William C. Steele. Describes work in connection with the building of a hollow concrete-steel dam on the Big Horn River, Wyoming. 800 w. Engng-Con—Jan. 6, 1909. No. 1589.

An Important Legal Decision Regarding Trench Excavation. Editorial on the decision given by the U. S. Circuit Court of Appeals in the case of Gammino v. Town of Dedham. 1200 w. Eng Rec—Jan. 2, 1909. No. 1418.

See also Air Compressors, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

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Failures.

The Failure Under Test Load of a Reinforced-Concrete Reservoir, Annapolis, Md. R. H. Danforth. Describes the construction and the failure. Ills. 1000 w. Eng News—Jan. 14, 1909. No. 1787.

Fireproof.

See Concrete, under MATERIALS OF CONSTRUCTION.

Floors.

See Concrete, under MATERIALS OF CONSTRUCTION.

Grain Elevators.

Grain Elevators at Tempelhof on the Teltow Canal (Magasin à Grains de Tempelhof, près Berlin, sur le Canal de Teltow). A. Bidault des Chaumes. Illustrated description. Plate. 2400 w. Génie Civil—Dec. 12, 1908. No. 1928 D.

Masonry.

Progress of Construction on the Cathedral of St. John the Divine. An illustrated description of recent work on this large cathedral under construction in New York City. 3000 w. Eng Rec—Jan. 23, 1909. No. 2019.

Piling.

Method of Making and Placing Pile Protection at Everett, Wash. Illustrated description of lock joint pipe protection. 2000 w. Eng Rec—Jan. 16, 1909. No. 1767.

The Best Form for Reinforced Concrete Piles (Ueber die günstigste Form der Betonpfähle). Richard Kafka. Discusses the shape of piles with reference to stability and ease of driving. Ills. 4000 w. Oest Wochenschr f d Oeffent Baudienst—Dec. 19, 1908. No. 1977 D.

The Creosoted Pile Bridge from Galveston Island to the Mainland. Describes the effect of sea water on the piles of the old bridge. 500 w. Eng News—Jan. 7, 1909. No. 1643.

See also Coffer Dams, and Dikes, under WATERWAYS AND HARBORS.

Reinforced Concrete.

Reinforced Concrete for Architectural Construction. Walter J. Francis. Read before the Ontario Assn. of Archts. Discussion of its history and principles. Ills. 4000 w. Contract Rev—Jan. 20, 1909. Serial, 1st part. No. 2014.

Cost of Concrete Construction as Applied to Buildings. Leonard C. Wason. Read before the Nat. Assn. of Cement Users. Gives actual costs of various parts of building construction. 3500 w. Eng Rec—Jan. 16, 1909. No. 1770.

Surfaces of Greatest Shearing Stresses for Steel Reinforced in Concrete. M. Koenen, in *Beton u. Eisen.* A discussion of the influence of shape, adhesive resistance, etc. 1000 w. Cement—Dec., 1908. No. 1732 C.

The Graphic Statics of Reinforced Concrete Sections. William Dunn. The treatment is based on Mohr's methods. Descriptive, with diagrams. 3500 w. Engng—Dec. 25, 1908. No. 1536 A.

Graphical Charts for the Determination of the Normal Stresses in Reinforced-Concrete Beams (Graphische Tafeln zur Bestimmung der Normalspannungen in Beton-Eisen-Trägern). J. Rieger. An exhaustive mathematical discussion of the construction and use of the charts. Ills. 70000 w. Oest Wochenschr f d Oeffent Baudienst—Dec. 12, 1908. No. 1976 D.

The Design of Continuous Beams and Slabs in Reinforced Concrete (Berechnung durchgehender Träger und Decken aus Eisenbeton). E. Elwitz. Mathematical. Ills. Serial, 1st part. 3800 w. Beton u Eisen—Dec. 14, 1908. No. 1986 F.

The Use of the Deflection Diagrams (Ueber die Verwertung des Durchbiegungsdiagramms). A. Kleinlogel. Discusses their application to the design of reinforced-concrete beams. Ills. Serial, 1st part. 1100 w. Beton u Eisen—Dec. 14, 1908. No. 1987 F.

The Examination of Designs for Reinforced Concrete Work. William Dunn. Abstract of a paper read before the Concrete Inst. Discusses designs, methods of calculation, importance of superintendence, etc. 2000 w. Surveyor—Dec 25, 1908. No. 1515 A.

Group of Reinforced-Concrete Buildings for a Wood Distillation Plant, Donald, Ont. Illustrates and describes a plant for the destructive distillation of wood into alcohol, with acetate of lime and charcoal as by-products. 2000 w. Eng News—Jan. 28, 1909. No. 2148.

A Notable Industrial Plant of Reinforced Concrete. Illustrates and describes the chemical mills of the Wood Products Co., at Donald, Ontario. 2500 w. Cement Age—Jan., 1909. No. 1734.

Reinforced Concrete Construction in the Hartford Armory. States the requirements and conditions and describes the construction. Ills. 3000 w. Eng Rec—Jan. 9, 1909. No. 1575.

Arch for Supporting a Floor of the Christopher Warehouse, Jacksonville, Fla. Illustrates and describes a reinforced-concrete warehouse in which a portion of the flooring and roof are carried by arches having a clear span of 54 feet. 1500 w. Eng Rec—Jan. 16, 1909. No. 1768.

Reinforced Concrete in Market Street Subway, Philadelphia. S. M. Swaab. A short illustrated description of the plant and construction methods used. 2000 w. Cement Age—Jan., 1909. No. 1733.

Reinforced Concrete Construction in Hall III in the Munich Exhibition Park (Bau der Halle III in Eisenbetonkonstruktion auf dem Ausstellungspark Theresienhöhe in München). Fritz Klette.

Illustrated description of a large building used for exhibition purposes. Plate. 2200 w. Beton u Eisen—Dec. 14, 1908. No. 1984 F.

See also Failures, Piling, Underpinning, and Waterproofing, under CONSTRUCTION; Sewers, under MUNICIPAL; Tanks, and Water Towers, under WATER SUPPLY; and Piers, under WATERWAYS AND HARBORS.

Specifications.

Specifications for Engineering Works. H. Laurence Butler. Read before the Civ. & Mech. Engrs.' Soc. Considers points that are essential to the production of a specification that shall fulfil its purpose. 3500 w. Surveyor—Jan. 15, 1909. No. 2055 A.

Stacks.

New 506-Ft. Chimney at Great Falls Smelter. Edwin Higgins. Illustrated detailed description of this largest chimney in the world. 2500 w. Eng & Min Jour—Jan. 16, 1909. No. 1761.

Steel.

Bending Moment Diagram. On the application of graphic methods to the study of beams and girders. 1000 w. Am Mach—Vol. 32, No. 2. No. 1750.

Structural Details in the New Grand Central Station, New York. Describes features of a very difficult problem in construction work. The building of a very large station on a site where over 1,000 train movements daily are constantly maintained. 3000 w. Eng Rec—Jan. 23, 1909. No. 2023.

See also same title, under MATERIALS OF CONSTRUCTION.

Tunneling Machines.

A Tunnel-Boring Machine. Illustrated description of a machine designed by E. F. Terry and O. S. Proctor, said to be capable of driving an 8-foot tunnel in rock without blasting. 1000 w. Sci Am—Jan. 9, 1909. No. 1644.

Tunnels.

Building the Raton Tunnels. Joseph Weidel. An illustrated account of the construction of the new tunnels on the Santa Fe R. R. in New Mexico. 4000 w. Cal Jour of Tech—Nov., 1908. No. 1796.

Methods Employed in Driving Alpine Tunnels: The Loetschberg Tunnel. Walton I. Aims. Explains methods that have made possible more rapid driving than has yet been attained in America. 1500 w. Eng News—Dec. 31, 1908. No. 1407.

Underpinning.

Method of Underpinning a Building Wall with a 55-Ft. Span Reinforced-Concrete Girder. Explains conditions and describes work at the waterworks pump house at Evansville, Ind. Ills. 1000 w. Engng-Con—Jan. 27, 1909. No. 2141.

Walls.

The Stability of Walls. Henry Adams. Read before the Soc. of Archts. Deals only with walls which have no load but their own weight to support, and no thrust but the wind to resist, discussing the general principles that determine stability. 5000 w. Surveyor—Jan. 15, 1909. No. 2054 A.

Waterproofing.

Tank Construction for Excluding Water from a Basement. Describes the reinforced-concrete tank for waterproofing the sub-basement of the Keyser Building in Baltimore, Md. Ills. 1500 w. Eng Rec—Jan. 9, 1909. No. 1573.

MATERIALS OF CONSTRUCTION.

Brick.

See Concrete, under MATERIALS OF CONSTRUCTION.

Cement.

Hardening Hydraulic Cements. Dr. W. Michaelis, Sr. Abstract of paper before the Assn. of German Cement Mfrs. Describes a new process. 4500 w. Sci Am Sup—Jan. 9, 1909. Serial, 1st part. No. 1648.

The Action of Frost on Cement and Cement Mortar, Together with Other Experiments on These Materials. Ernest R. Matthews, and James Watson. Describes in detail a series of experiments, giving results of interest and value. 3000 w. Pro Am Soc of Civ Engrs—Jan., 1909. No. 2122 E.

The Effect of Electrolytes on the Setting of Cement (Die Wirkung von Elektrolyten auf die Zementabbindung). Dr. Rohland. Considers the influence of various salts. 2500 w. Stahl u Eisen—Dec. 9, 1908. No. 1942 D.

Concrete.

Building Materials. H. D. Searles-Wood. Read before the Archt. Assn., London. Deals with concrete, both plain and reinforced, mortar, bricks, stone, and wood. Discussion. 12000 w. Builder—Jan. 16, 1909. No. 2046 A.

Concrete Aggregates. Explains the scope of a special commission of the British Fire Prevention Committee to report on suitable aggregates for concrete floors intended to be fire-resisting. 2000 w. Surveyor—Jan. 8, 1909. No. 1809A.

Strength of Concrete Joints. Joshua L. Miner. Reports results of a series of tests made in the laboratories of Lafayette College. Ills. Discussion. 4500 w. Pro Engrs' Soc of W Penn—Dec., 1908. No. 1744 D.

Mortar.

See Concrete, under MATERIALS OF CONSTRUCTION.

Reinforced Concrete.

Emperger's Tests on Reinforced Concrete-Columns (Empergers Versuche mit betoneisernen Säulen). Max R. v. Thullie. Summarizes and discusses the

results of recent tests by Fritz von Emperger. Ills. 4500 w. Zeitschr d Oest Ing u Arch Ver—Dec. 18, 1908. No. 1981 D.

See also Concrete, under MATERIALS OF CONSTRUCTION.

Steel.

Steel Work. C. V. Childs. Remarks on the influence of steel as a building material, tracing the development of steel frame buildings. 1800 w. Archt, Lond—Jan. 8, 1909. Serial, 1st part. No. 1798 A.

Nickel Steel for Bridges. R. E. Chadwick. A review of J. A. L. Waddell's paper on this subject. 2500 w. Can Engr—Jan. 15, 1909. No. 1772.

Stone.

See Concrete, under MATERIALS OF CONSTRUCTION.

Timber.

Forest Conservation. R. S. Kellogg. Timber production and its proper handling and related matters. General discussion. 7000 w. Jour N Eng W-Wks Assn—Dec., 1908. No. 1881 F.

See also Concrete, under MATERIALS OF CONSTRUCTION.

Timber Preservation.

Wood Preservation by the Open Tank Process. Ernest F. Hartmann. Suggestions for the proper treatment of timber, describing the process named. Ills. 4000 w. Eng News—Dec. 31, 1909. No. 1405.

MEASUREMENT.

Asphalt Testing.

Asphalt-Testing — Penetration. Harry Tipper. Recommends a limit of variation in penetrations at different temperatures. 1200 w. Munic Jour & Engr—Jan. 6, 1909. No. 1489.

Cement Testing.

Free Lime in Portland Cement. Alfred H. White. Describes a simple microscopic test for free lime and discusses the result of its application to a number of cements. Ills. 3500 w. Jour Ind & Engng Chem—Jan., 1909. No. 2038 E.

Concrete Testing.

Specifications for Test Specimens of Concrete to be Immersed in Sea Water by the United States Navy Department. Specifications drawn for guidance in conducting a series of tests under government supervision at the Navy Yard at Charlestown, Mass. 1500 w. Engng-Con—Dec. 30, 1908. No. 1452.

Surveying.

The Topographical Survey of the City of Baltimore. Notes from a paper by Joseph W. Shirley, submitted to the Engrs.' Club of Baltimore, giving a general account of this work. 2800 w. Eng Rec—Jan. 2, 1909. No. 1424.

Sketch Mapping in Southern Nigeria. L. H. L. Huddart. Read before the Inst. of Civ. Engrs. On the making of a preliminary sketch map of a little-known district. 2500 w. Min Jour—Dec. 19, 1908. Serial, 1st part. No. 1531 A.

MUNICIPAL.

City Planning.

The New Capital for Australia. Information concerning the site selected, treating it from the topographical, engineering and related points of view. 3000 w. Engr, Lond—Jan. 8, 1909. No. 1823 A.

Drainage.

The Storm Drainage of Pretoria. H. D. Badcock. Describes the situation and conditions, and the means taken to prevent flooding. 1200 w. Engr, Lond—Jan. 15, 1909. No. 2083 A.

Refuse Disposal.

See Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Roads.

Report on the Recent First International Road Congress. Nelson P. Lewis. Condensed report made to the Board of Estimate and Apportionment of the City of New York, summing the information acquired by the American delegates. 8800 w. Eng News—Jan. 21, 1909. No. 1873.

Good Roads in the South. Joseph Hyde Pratt. An account of what is being done in road construction. 3500 w. Mfrs' Rec—Jan. 7, 1909. (Special No.) No. 1565 C.

Highway Construction in New York State. J. C. Gotwals. Describes the steps necessary in state road improvement, and the method of macadam surfacing. 3200 w. Engr, Pa—Dec., 1908. No. 2010 D.

Notes on Highway Improvements. D. McD. Campbell. Suggestions in regard to drainage, location, grades, and other practical matters. Ills. 5000 w. Can Engr—Jan. 8, 1909. No. 1654.

Standard Details for Highway Construction. Cuts and description of construction work under supervision of the Massachusetts state highway commission. 1100 w. Engng-Con—Jan. 6, 1909. No. 1590.

The Construction of Sand-Clay Roads. W. L. Spoon. From an address before the Roads School, at Waterloo, Ia. Discusses the materials and best method of mixing them. 1400 w. Engng-Con—Jan. 27, 1909. No. 2143.

Specifications and Notes on Macadam Road Construction. A. N. Johnson. Considers in detail the road-bed, thickness of macadam, cross-slope, materials, etc., methods of construction, and related subjects. 12500 w. Jour W Soc of Engrs—Dec., 1908. No. 1859 D.

The Tarring of Roads. Prevost Hubbard. Abstract of Bul. 34 of the Office of Public Roads, Dept. of Agriculture. Illustrated explanation of how the work is done. 3500 w. Sci Am Sup—Jan. 2, 1909. No. 1432.

We supply copies of these articles. See page 1071.

Dust Prevention on Public Roads (Die Staubbekämpfung auf offenlichen Strassen). Herr Fichtner. Discusses the use and effect of various dust preventatives. 4000 w. Zeitschr d Mit Motorwagen Ver—Dec. 31, 1908. No. 1973 D.

Sanitation.

Sanitary Engineering in 1908. Reviews the Report of the Royal Commission, and also progress, new works and other matters. 2500 w. Engr, Lond—Jan. 1, 1909. No. 1714 A.

Sewage Disposal.

An Electrically-Driven Sewage System. Illustrated description of the installation of ejectors at Whickham, near Newcastle-on-Tyne. 1700 w. Elect'n, Lond—Jan. 1, 1909. No. 1700 A.

The Royal Prussian Testing Institute for Water and Sewage Purification A. Elliott Kimberly. Explains the function of the Institute, the departments, general features, etc. 1500 w. Eng News—Jan. 28, 1909. No. 2154.

Sewers.

Cost of a 66-Inch Brick Sewer at Gary, Indiana. E. M. Scheflow. Gives itemized labor cost of the work. 1500 w. Eng Rec—Jan. 2, 1909. No. 1422.

The Use of Concrete in Sewer Construction. Peter Gillespie. Discusses the relative advantages of brick and concrete. 3000 w. Contract Rec—Jan. 6, 1909. No. 1653.

The Construction of the Bronx Valley Sewer. Illustrates and describes the construction of this sanitary sewer which is to serve eight villages along the Bronx River. 5000 w. Eng Rec—Jan. 9, 1909. No. 1570.

Building a Reinforced Concrete Pipe Sewer. Alexander J. Taylor. Read before the Am. Soc. of Munic. Imp. Describes methods of construction. 2500 w. Munic Engng—Jan., 1909. No. 1739 C.

Methods and Cost of Constructing a Concrete Sewer in Freezing Weather. Describes work at Fond-du-Lac, Wis., during Nov. and Dec., 1908, with the thermometer ranging from 15 degrees below zero, to the freezing point. Ills. 1500 w. Engng-Con—Jan. 27, 1909. No. 2142.

Asphalt Sewer-Pipe Joints at Monmouth, Illinois. John S. Bates. Explains conditions requiring a joint-filler, and the use of asphalt. 1500 w. Eng Rec—Jan. 9, 1909. No. 1577.

Sewer Trenches.

See Excavation, under CONSTRUCTION.

WATER SUPPLY.

Aqueducts.

An Old Aqueduct and Its Development. Albert L. Sawyer. A review of the history of the Haverhill (Mass.) Aqueduct Co. Ills. 6500 w. Jour N Eng W.Wks Assn—Dec., 1908. No. 1884 F.

The Hudson River Crossing of the Catskill Aqueduct. William B. Hoke. An account of the engineering work done with the aim of determining the best crossing, the material through which a tunnel must pass, etc. Ills. 2000 w. Engr, Pa—Dec., 1908. No. 2008 D.

Ashokan.

See Aqueducts, and Reservoirs, under WATER SUPPLY.

Conservation.

The Conservation of Water Resources. M. O. Leighton. Brief discussion of the steps necessary in the conservation of the water resources of the United States. 2500 w. Jour N Eng W-Wks Assn—Dec., 1908. No. 1880 F.

Dams.

Stresses in Masonry Dams. William Cain. Report of an investigation made to determine the amounts and distribution of the stresses in a masonry dam, at points not too near the foundations. 3500 w. Pro Am Soc of Civ Engrs—Jan., 1909. No. 2124 E.

The Granite Reef Dam and Gate Mechanism. F. Teichman. Describes particularly the diversion dam and the devices that turn the water into the two canals, in the Salt River Irrigation Project, Arizona. Ills. 2000 w. Eng News—Jan. 7, 1909. No. 1636.

See also Excavation, under CONSTRUCTION; and Lock Gates, under WATERWAYS AND HARBORS.

Discharge Coefficients.

On the Variation of the Coefficient of Discharge for Small Orifices. T. P. Strickland. Describes experimental work and the apparatus used. 4500 w. Can Soc of Civ Engrs—Jan. 7, 1909. No. 1742 N.

Ditches.

The Yukon Ditch. T. A. Rickard. Illustrated description of a system of ditch, pipe and flume which has a total length of more than 70 miles. 2500 w. Min & Sci Pr—Jan. 16, 1909. Serial, 1st part. No. 2018.

Filtration.

The New Covered Filters for Yonkers, N. Y. Illustrated detailed description of plant for filtering the river water. 3000 w. Eng Rec—Jan. 16, 1909. No. 1763.

Electrically Operated Filter Valves at Cincinnati, Ohio. F. H. Stephenson. The methods used are illustrated and described. 900 w. Eng Rec—Jan. 16, 1909 No. 1771.

See also Philadelphia, under WATER SUPPLY.

Fire Protection.

Private Fire Protection and Insurance Rules. Gorham Dana. An explanation of the work of the insurance engineer, discussing the need of private fire protection, especially automatic sprinklers. General discussion. Ills. 8500 w. Jour

N Eng W-Wks Assn—Dec., 1908. No. 1885 F.

Ground Waters.

An Instrument for the Determination of Ground-Water Levels (Messwerkzeug für die Lagebestimmung des Grundwasserspiegels). G. Thiem. Illustrated description of the apparatus and the method of use. 2000 w. Gesundheits-Ing—Dec. 12, 1908. No. 1966 D.

Irrigation.

Mechanical Irrigation Stations on the Nile. J. B. Van Brussel. Illustrates and describes an irrigation scheme carried out at Wadi Kom-Ombo, in Upper Egypt. 3000 w. Engineering Magazine—Feb., 1909. No. 2155 B.

Irrigation in Hawaii. George B. Sturgeon. Describes the conditions, and the irrigation works for the production of sugar-cane. Ills. 2800 w. Cal Jour of Tech—Nov., 1908. No. 1795.

Irrigation in Victoria. H. G. M'Kinney. An account of what has been done and the irrigation policy 2500 w. Eng Rec—Jan. 16, 1909. No. 1764.

Michigan City, Ind.

Method of Investigation of Character of Water Supply of Michigan City, Ind. A report of the investigations made and the results. 2000 w. Munic Engng—Jan., 1909. No. 1740 C.

New Jersey.

Report of the New Jersey State Water Supply Commission. Discusses the water rights troubles. 1800 w. Eng News—Jan 7, 1909. No. 1639.

Orifices.

See Discharge Coefficients, under WATER SUPPLY.

Philadelphia.

A Glance at the Water Supply of Philadelphia. John C. Trautwine, Jr. Notes on the history of the supply, progress and present condition of the filtration plant, etc. Ills. 5500 w. Jour N Eng W-Wks Assn—Dec., 1908. No. 1883 F.

Pipe Lines.

See Ditches, under WATER SUPPLY.

Pipe Strength.

The Collapse of Tubes Under External Pressure. S. E. Slocum. A study of recent experiments. 3500 w. Engng—Jan. 8, 1909. No. 1818 A.

See also Steam Pipes, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Pipe Trenches.

See Excavation, under CONSTRUCTION.

Purification.

Ozone Purification Plants. S. H. Hart. Describes the J. Howard Bridge process as installed in a small municipal plant in Canada. 2000 w. Elec Rev, N Y—Jan. 9, 1909. No. 1656.

See also Sewage Disposal, under MUNICIPAL.

Reservoirs.

Progress on the Ashokan Reservoir. A report of progress on the work in the Catskill Mts. on this reservoir for additional supply of New York City. Ills. 2000 w. Eng Rec—Jan. 16, 1909. No. 1769.

The New High Service Reservoir of the Baltimore Water System. Illustrated detailed description. 2000 w. Eng Rec—Jan. 23, 1909. No. 2027.

See also Failures, under CONSTRUCTION.

Review of 1908.

Water Supply in 1908. A review of works carried out during the year, and related matters. 2800 w. Engr, Lond—Jan. 1, 1909. No. 1713A.

Stream Discharges.

Stream Flow Data. Charles E. Chandler. Gives tables of the flow of the Sudbury River, Nashua River, and Merrimac River, with explanatory notes. 2000 w. Jour N Eng W-Wks Assn—Dec., 1908. No. 1882 F.

Tanks.

A Concrete Feed-Water Storage Tank. Warren H. Miller. Directions for building. Ills. 1500 w. Power—Jan. 26, 1909. No. 2090.

Vancouver.

Vancouver's Water Supply. An illustrated account of the additional supply obtained from Seymour Creek. 1700 w. Can Engr—Jan. 15, 1909. No. 1774

Water Towers.

A Novel Reinforced-Concrete Tower and Tank. R. B. Tufts. Illustrated description of a structure at Atlanta, Ga. 1500 w. Eng News—Jan. 7, 1909. No. 1642.

Reinforced-Concrete Water Tower for the Atlantic Compress Company, Atlanta. R. B. Tufts. Illustrated detailed description. 1500 w. Eng Rec—Jan. 2, 1909. No. 1421.

WATERWAYS AND HARBORS.

Canada.

Canada and Her Waterways. J. G. Sing. Remarks on the extent of Canada, the importance of the waterways, their recent improvement, and work in progress. 3000 w. Can Engr—Jan. 22, 1909. No. 2016.

Cleveland, O.

Recent Improvements to the Harbor at Cleveland, Ohio. Illustrated description of breakwater extensions, and changes, channel deepening, and other important changes. 1500 w. Eng Rec—Jan. 16, 1909. No. 1766.

Cofferdams.

Steel Piling at Power-House Intakes at Omaha. Describes intakes constructed under difficult conditions by handling the work in cofferdams of steel sheet piling. 1000 w. Eng Rec—Jan. 2, 1909. No. 1423.

Dikes.

A Concrete-Pile Dike for River Bank

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Revetment. Describes test work constructed near Ellwood, Kansas, giving cost. 1000 w. Eng Rec—Jan. 23, 1909. No. 2025.

Dry Docks.

Extension of Malta Naval Dockyard and Harbor. Maps, plans and illustrated detailed description of new works which have cost nearly three millions sterling. Plates. 6000 w. Engng—Jan. 1, 1909. Serial. 1st part. No. 1704 A.

French West Africa.

Harbors and Rivers of French West Africa (Les Ports et les Fleuves de l'Afrique occidentale Française). Illustrated description of harbors and navigable waterways and a discussion of commercial possibilities. 9000 w. Rev Gen des Sci—Dec. 15, 1908. No. 1916 D.

Georgian Bay Canal.

The Georgian Bay Ship Canal. J. G. G. Kerry. An interesting discussion of the economic and financial elements of the undertaking, and some engineering details relating to water-supply at the summit. 2500 w. Engineering Magazine —Feb., 1909. No. 2159 B.

Harbors.

Hamburg, Antwerp and Other European Harbors (Los Puertos de Hamburgo, Amberes y varios otros de Europa). Review of a publication by the Brazilian Minister of Public Works describing large European harbors and discussing the application of their principles of construction to the port of Buenos Ayres. Ills. Serial. 1st part. 4000 w. Ingenieria—Nov. 15, 1908. No. 1939 D.

Hungary.

Hungarian Waterways (Die Wasserstrassenaktion in Ungarn). Carl Grünhut. Gives in tabular form details of present and projected canals in Hungary. Plates. 5500 w. Oest Wochenschr f d Oeffent Baudienst—Dec. 5, 1908. No. 1974 D.

Lock Gates.

The Design of the Lock Gates and of an Emergency Dam for the Panama Canal. Information from the recent report of the Isthmian Canal Commission in regard to the design of these lock gates and the dam. 1000 w. Eng News—Dec. 31, 1908. No. 1408.

Locks.

See Panama Canal, under WATERWAYS AND HARBORS.

Manitowoc, Wis.

The Improvement of Manitowoc Harbor, Wisconsin. Illustrated description of reconstruction work to meet modern conditions. Cribs from the old works are removed to the new. 2500 w. Eng Rec—Jan. 23, 1909. No. 2024.

Panama Canal.

The Meaning of the Panama Canal to the South. John Barrett. Discusses the effect on South American trade and the importance of preparing by acquiring reliable information concerning these Latin-American countries. 3000 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1558 C.

The Panama Canal Work Cassius E. Gillette. A defense of the day labor method of building the canal, with editorial reply. 4000 w. Engng-Con—Dec. 30, 1908. No. 1455.

The Foundations for the Gatun Locks. Review of a report by Major Chester Harding, giving information based on recent investigations, concerning materials, conditions, etc. Ills. 2000 w. Eng Rec—Jan. 2, 1909. No. 1420.

See also Lock Gates, under WATERWAYS AND HARBORS.

Piers.

Cost of Small Concrete Piers. J. H. Ryckman. Describes work in Canada, giving cost. 1000 w. Eng Rec—Jan. 23, 1909. No. 2029.

The New Piers for Transatlantic Steamships, Chelsea Improvement, New York City. Illustrated description of the largest piece of wharfing construction ever undertaken in the port of New York. 5000 w. Eng News—Jan. 14, 1909. Plate. No. 1785.

Piling.

See same title, under CONSTRUCTION.

Pollution.

The Massachusetts State Board of Health on Pollution of Boston Harbor from the Moon Island Outlet of the Boston Sewerage System. A recent report on this subject. 1000 w. Eng News—Dec. 31, 1908. No. 1409.

Review of 1908.

Harbors and Waterways, 1908. A review of progress during the past year. 3500 w. Engr, Lond—Jan. 1, 1908. No. 1711 A.

River Improvement.

Report of the Waterways Commissioner of Wisconsin. Gives a portion of this report, by Hon. Ray S. Reid. which presents new views concerning the improvement of navigable rivers. Also editorial. 8000 w. Eng News—Jan. 28, 1909. No. 2149.

Shore Protection.

See Dikes, under WATERWAYS AND HARBORS.

U. S. Waterways.

Value of Inland Waterways from a Naval Standpoint. George W. Melville. Read before the Inland Waterways Conference. 2000 w. Naut Gaz—Jan. 14, 1909. No. 1757.

Water Powers.

State Control of Water Power. Curtis E. Lakeman. Presents reasons for the adoption of public policies of water conservation. 4500 w. Am Rev of Revs—Jan., 1909. No. 1736 C.

The Administration's Positon Regard-

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ing Water Power Development. A message to the House of Representatives, by President Roosevelt. 3000 w. Eng Rec—Jan. 23, 1909. No. 2021.

Potentiality of Water-Power. Resources of the South. H. von Schon. Information concerning the available power and the explanation of the retarded development. 4000 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1556 C.

The Value of Southern Water-Power Investments. Francis R. Weller. Points for the guidance of those interested in their development. 3000 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1557 C.

The Water Powers of Sweden, Norway and Switzerland (Die Wasserkräfte Schwedens, Norwegens und der Schweiz). Eduard Engelmann. Brief descriptive notes on the leading water powers of these three countries. Ills. Serial. 1st part. 5500 w. Zeitschr f d Gesamte Turbinenwesen—Dec. 10, 1908. No. 1957 D.

MISCELLANY.

Review of 1908.

Engineering in the United States in 1908. A general review, the present number deals with railways and bridges. 6000 w. Engr, Lond—Jan. 15, 1909. Serial. 1st part. No. 2080 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radio-Telegraphy.

The Cooling of Rotating Discs Considered in Connection with Marconi's New Generator of Continuous Oscillations. Information from a contribution by R. Rüdenberg in the "Jahrbuch, der Drahtlosen Telegraphie." 1500 w. Elect'n, Lond—Dec. 25, 1908. No. 1524 A.

A Directive System of Wireless Telegraphy. E. Bellini and A. Tosi. Describes the author's bilateral directive wireless telegraph system and gives particulars of a new unilateral directive method. 1500 w. Elect'n, Lond—Jan. 15, 1909. No. 2069 A.

The Bellini-Tosi Directive System of Wireless Telegraphy and Telephony (Télégraphie et Téléphonie sans Fils dirigeables Bellini-Tosi). M. Tosi. Illustrated detailed description. 6000 w. Bul Soc Int des Elecns—Dec., 1908. No. 1906 F.

Telegraphone.

The Telegraphone. Charles K. Fankhauser. Explains the principles embodied, its accomplishments, applications and influence. 3500 w. Jour Fr Inst—Jan., 1909. No. 1848 D.

Telegraphy.

The Technical Problems of Telegraphy and Telephoney (I Problemi tecnico-scientifici della Telegraphia e della Telefonia). G. di Pirro. A general discussion of electrical methods of communication. Ills. 5500 w. Ann d Soc d Ing e d Arch Ital—Dec. 15, 1908. No. 1935 F.

Telephone Tolls.

The Economical Development of Toll Territory. Frank F. Fowle. Considers the principal factors in building up a successful toll plant. 4000 w. Elec Rev, N Y—Jan. 9, 1909. Serial. 1st part. No. 1658.

Telephone Transmitters.

The Two-Tone Vibrating Transmitter and Inductive Signaling. Edward Raymond-Barker. Discusses its application especially to maintaining communication between ship and shore during cable repair. 4000 w. Elect'n, Lond—Jan. 15, 1909. No. 2073 A.

Telephony.

Reflection of Waves in Telephone Lines (Reflexionen in Fernsprechleitungen). F. Breisig. Mathematical discussion. Ills. 3000 w. Elektrotech Zeitschr—Dec. 17, 1908. No. 2113 D.

The Telephone Problem in France (Le Problème Téléphonique actuel en France). Albert Turpain. Discusses faults of practice and the lessons to be learned from the recent destruction by fire of a large exchange in Paris. 3200 w. Rev Gen des Sci—Dec. 30, 1908. No. 1918 D

DISTRIBUTION.

Current Rectifiers.

The Mercury Rectifier. R. P. Jackson. Describes its operation, application, and related matters. Ills. Discussion. 4000 w. Pro Engrs' Soc of W Penn—Dec., 1908. No. 1743 D.

Switches.

The Design of Contact Springs and Contact Brushes for Switching Apparatus (Studien über die Berechnung der Kontaktfedern und Kontaktbürsten für Schaltapparate). Robert Edler. Discusses the calculation and standardization of apparatus of this type. Ills. Serial. 1st part. 4800 w. Elektrotech u Maschinenbau—Dec. 6, 1908. No. 1994 D.

Wiring.

Wiring a Finished Dwelling Without Defacement. Illustrated description of methods used in a house in New York. 1200 w. Elec Wld—Jan. 7, 1909. No. 1672.

The Craze for Cheap Wiring. S. G. Castle Russell. Discusses interests likely to be affected by the adoption of cheap wiring methods, and the systems proposed. 3500 w. Elec Rev, Lond—Jan. 8, 1909. No. 1806 A.

We supply copies of these articles. See page 1071.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Comparative Weights and Costs of Alternating and Continuous-Current Generators. A. G. Ellis. Investigation to determine the relative weights and costs and the influence on the rated speed and output. 2000 w. Elec Engng—Dec. 31, 1908. No. 1699 A.

The Relative Proportions of Copper and Iron in Alternating- and Continuous-Current Generators. A. G. Ellis. Explains the preponderance of copper in c. c. designs as compared with a. c. designs and other comparisons. 1700 w. Elec Engng—Jan. 7, 1909. No. 1803 A.

Deformation of Pressure Curves Due to Load in Alternate Current Generators. Egon Siedek. An oscillographic investigation of the effect of armature reaction in alternators. 1200 w. Elect'n, Lond—Jan. 15, 1909. No. 2071 A.

Fluctuations in the Speed of the Rotors of Alternators Operating in Parallel. George H. Shepard. An analysis of the interactions of two alternators in parallel explaining the means that may be employed for stopping the enlargement of the angle of phase displacement while it is still very small. 1800 w. Elec Wld—Jan. 28, 1909. No. 2126.

A. C. Motors.

The Single-Phase Commutator-Type Motor. B. G. Lamme. From a paper before the Phila. Sec. of the Am. Inst. of Elec Engrs. Explains the cause of trouble in commutating alternating currents and the problems encountered in designing such motors. 4500 w. Elec Jour—Jan., 1909. No. 1842.

Air Gaps.

A Diagram for Correction Coefficients for Air-Gap Reluctances. T. C. Baillie. Quotes experiments verifying Carter's formula, and gives a diagram from which the coefficients can be read. 500 w. Elect'n, Lond—Jan. 8, 1908. No. 1807 A.

Brakes.

Friction Brakes. Henry D. James. Aims to show the importance of careful design and application of friction brakes to suit stated conditions. Ills. 1700 w. Elec Jour—Jan., 1909. No. 1844.

Commutators.

Some Remarks on Flatting and Blackening of Commutator Bars. Considers troubles which, if not rectified, render the machine unfit for service. 1000 w. Elec Rev, Lond—Jan. 15, 1909. No. 2064 A.

Controllers.

Automatic Control of Direct-Current Motors in Industrial Service. D. E. Carpenter. Remarks on the importance of selecting a proper controller with an illustrated description of a type of magnet switch controller and its operation. 3000 w. Elec Jour—Jan., 1909. No. 1843.

D. C. Dynamos.

See A. C. Dynamos, under DYNAMOS AND MOTORS.

D. C. Motors.

See Controllers, under DYNAMOS AND MOTORS.

Induction Motors.

Methods of Starting Large Three-Phase Induction Motors. J. W. Rogers. Briefly describes the construction of such motors and the methods employed for starting them. 2500 w. Prac Engr—Jan. 15, 1909. No. 2050 A.

Belt-Leakage in Induction Motors. R. E. Hellmund. Aims to investigate and demonstrate, in a general way, the characteristics of belt-leakage. 3000 w. Elec Rev, N Y—Jan. 2, 1909. No. 1469.

Some Graphical Solutions to Three-Phase Problems. Leonard Solomon. Gives a graphical method of calculating the resistances to be inserted in the rotor circuit in two cases, based on the Heyland diagram. 1200 w. Elect'n, Lond—Jan. 15, 1909. No. 2068 A.

See also Starters, under DYNAMOS AND MOTORS.

Interpoles.

Some Notes on Commutating-Pole Design. E. O. Turner. Read before the Students' Sec. of the Inst. of Elec. Engrs. at Glasgow. Explains method of finding the necessary ampere-turns and the dimensions for the pole-shoe and pole-core. 2000 w. Elect'n, Lond—Jan. 15, 1909. No. 2067 A.

Railway Motors.

Single-Phase Railway Motors (Les Alternomoteurs monophase de Traction). M. Henry. A general review. The first part discusses the principal types, their characteristics, the choice of frequency, and efficiency. Ills. Serial. 1st part. 3500 w. L'Elecn—Dec. 19, 1908. No. 1923 D.

Starters.

Rheostatic Starters for Induction Motors. Dr. Benjamin F. Bailey. A comparison of the rheostatic starter and the auto-starter. 2000 w. Elec Wld—Jan. 2, 1909. No. 1476.

Windings.

Factors Governing the Space Utilization of Electromagnetic Windings. Charles R. Underhill. Discusses some of the influences affecting the space utilization coefficient. 1200 w. Elec Wld—Jan. 14, 1909. No. 1789.

ELECTRO-CHEMISTRY.

Alkalis.

See Chlorine, under ELECTRO-CHEMISTRY.

Calcium Cyanamide.

The Manufacture of Calcium Cyanamide (La Fabrication industrielle de la Cyanamide de Calcium). H. Marchand. A description of the various electrical

methods. 3500 w. Rev Gen des Sciences—Dec. 30, 1908. No. 1919 D.

The Utilization of Atmospheric Nitrogen for the Production of Calcium Cyanamide and the Employment of the Latter in Agriculture and in Chemistry (L'Utilisation de l'Azote atmosphérique dans la production de la Cyanamide de Calcium et son Emploi en Agriculture et en Chemie). Albert Frank. Ills. 5000 w. Rev d'Electrochimie—Nov., 1908. No. 1910 F.

Chlorine.

The Electrolytic Chlorine and Alkali Industry (Etat actuel de l'Industrie du Chlore et des Alcalis électrolytiques). André Brochet. A review of methods and the present status of the industry. Ills. 5600 w. Bul Soc Int des Elecns—Dec., 1908. No. 1905 F.

Detinning.

The Detinning of Tin-Plate Scrap and the Economics of the Process (Der Entzinnung der Weissblechabfälle und ihre wirtschaftliche Bedeutung). K. Goldschmidt. Describes various methods proposed and in use and discusses the economic importance of the detinning industry. Ills. 4400 w. Stahl u Eisen—Dec. 30, 1908. No. 1945 D.

Electro-Metallurgy.

Some Recent Advances in Electro-Chemistry and Electro-Metallurgy. Saul Dushman. Discusses briefly the utilization of atmospheric nitrogen, electric smelting, advances in electro-metallurgy, etc. 2500 w. Ap Sci—Jan., 1909. No. 2095 C.

Silundum, a New Product of the Electric Furnace. F. Bölling. An account of a product obtained when carbon is heated in a vapor of silicon. 2000 w. Elec-Chem & Met Ind—Jan., 1909. No. 1682 C.

Electric Furnace for the Production of Carbon Bisulphide. Explains some of the uses of bisulphide of carbon, and illustrates and describes the furnace used for its manufacture. 1600 w. Elec Rev, Lond—Dec. 25, 1908. No. 1520 A.

The Influence of Cheap Electricity on Electrolytic and Electrothermal Industries. E. A. Aschroft. Read before the Faraday Soc. An interesting paper discussing cost of electrical energy, per kilowatt per annum when produced by steam engines, gas engines, oil engines, and water power. 3500 w. Elec Engr, Lond—Jan. 1, 1909. No. 1691 A.

Heat Conductance and Resistance of Composite Bodies. Carl Hering. Gives formulæ for calculating the heat conducted through the walls of an electric furnace, with explanatory notes. 3500 w. Elec-Chem & Met Ind—Jan., 1909. No. 1675 C.

Galvanizing.

Researches on Electro-Galvanizing (Einige Versuche über galvanische Verzinkung). Carl Richter. Gives results of tests made under various conditions. 2000 w. Elektrochem Zeitschr—Dec., 1908. No. 1946 D.

Ozone.

The Thermal Production of Ozone. Arthur W. Ewell. Reviews the experimental work in this field. 2000 w. Elec-Chem & Met Ind—Jan., 1909. No. 1681 C.

ELECTRO PHYSICS.

Electrons.

Theory of Electrons. Sir Oliver Lodge. An explanation. 2000 w. Sci Am Sup—Jan. 2, 1909. No. 1431.

Recent Electrical Theory. J. Franklin Meyer. Reviews the attempts to formulate an electrical theory and explains the electron theory. 3000 w. Engr, Pa—Dec., 1908. No. 2011 D.

Magnetic Alloys.

Experiments with Heusler's Magnetic Alloy. J. G. Gray. Abstract of paper read before the Roy. Soc. of Edinburgh. Describes investigations of the magnetic properties at different temperatures. 1200 w. Elect'n, Lond—Dec. 25, 1908. No. 1525 A.

Radio-Activity.

Rays of Positive Electricity. Sir J. J. Thomson. Delivered at the Royal Inst. Describes a new investigation of Goldstein's "canal rays." Ills. 5000 w. Sci Am Sup—Jan. 2, 1909. No. 1430.

Skin Effect.

The Superficial Localization of Currents and Variable Fluxes (Sur la Localisation superficielle des Courants et Flux variables). P. Boucherot. A simplified mathematical discussion. Ills. 3800 w. Bul Soc Int des Elecns—Nov., 1908. No. 1904 F.

Spark Gaps.

Note on the Electrical Resistance of Spark Gaps. R. A. Houstun. Abstract of paper read before the Roy. Soc. of Edinburgh. Describes the effect of changing the material of the electrode. 1000 w. Elect'n, Lond—Dec. 25, 1908. No. 1526 A.

GENERATING STATIONS.

Accumulators.

Storage Batteries in Mining Service. George A. Iler. Illustrates and describes a plant installed at Prudence, W. Va. 1000 w. Elec Wld—Jan. 2, 1909. No. 1472.

The Theoretical Calculation of the Battery Capacity Required for a Given Load. Dr. W. Lulofs. Aims to show that the Peukert formula holds good for English makes, and to calculate the respective values of the constants n and a. 1500 w. Elect'n, Lond—Jan. 1, 1909. No. 1698 A.

Central Stations.

Heat-Losses in an Electric Power Station. Abstract of a paper by F. H. Corson, before the Inst. of Civ. Engrs. A report of trials. 1200 w. Engng—Jan. 1, 1909. No. 1706 A.

We supply copies of these articles. See page 1071.

Electricity Supply in the Tropics. An account of some of the problems encountered in the erection and operation of a plant. 1800 w. Elec Rev, Lond—Jan. 1, 1909. No. 1696 A.

New Turbine Plant at Allentown, Penn. John I. Baker. Illustrates and describes an alternating-current plant with special facilities for handling coal and ash. 3000 w. Power—Jan. 5, 1909. (Special No.) No. 1484 D.

Hampton Power Plant of the D., L. & W. R. R. Warren O. Rogers. Illustrated description of a large central plant supplying steam to fire collieries and electricity to fifteen additional mines. 3000 w. Power—Jan. 19, 1909. No. 1832.

Station No. 3 of the Rochester Railway & Light Company. Illustrated description of the largest steam generating station of this company. 3500 w. Elec Wld—Jan. 21, 1909. No. 1868.

Quarry Street Station of the Commonwealth Edison Company, Chicago. William Keily. Illustrates and describes the characteristics of this important station, pointing out the reasons for its creation. 5000 w. Elec Wld—Jan. 2, 1909. No. 1470.

Electricity Supply at St. Albans. Illustrated description of an English plant combining a refuse destructor and generating station. 3000 w. Elec Engng—Dec. 24, 1908. No. 1516 A.

Cost Keeping.

Cost Keeping in the Central Station Contracting Department. Ludwig Kemper. From a paper read before the N.-W. Elec. Assn. Describes the system used at Albert Lea, Minn. 1000 w. Elec Wld—Jan. 28, 1908. No. 2127.

Costs.

Representative Steam-Plant Operating Costs. Howard S. Knowlton. A comparative study of itemized costs. 2500 w. Engineering Magazine—Feb., 1909. No. 2163 B.

Hydro-Electric.

The Analysis of an Hydro-Electric Project. H. von Schon. The features of the market analysis are discussed, the power load inquiry, the power output, the cost, etc. General discussion. 13000 w. Jour W Soc of Engrs—Dec., 1908. No. 1856 D.

American Hydro-Electric Construction Work Abroad. H. Lester Hamilton. Illustrates and describes important installations in various countries. 3000 w. Cassier's Mag—Jan., 1909. No. 1728 B.

System of the Rochester Railway & Lighting Company. Illustrated description. The chief source of power is the Genesee River, but steam-driven generators are used and power is also transmitted from Niagara Falls. 2000 w. Elec Wld—Jan. 14, 1909. No. 1788.

Large Water-Power Stations of the Rochester Railway & Light Company. Illustrated descriptions of stations 4 and 5. 2000 w. Elec Wld—Jan. 28, 1909. No. 2125.

An Extensive Power System in the South. Cecil P. Poole. Illustrated account of the development of the Southern Power Co., in the Carolinas. 4000 w. Power—Jan. 5, 1909. (Special No.) No. 1478 D.

The Hemsjö Power Company, Sweden. P. Frenell. Illustrated description of features of this hydro-electric plant showing the latest electrical developments in Sweden. 1400 w. Elect'n, Lond—Jan. 8, 1909. Serial. 1st part. No. 1808 A.

A Recent Swedish Hydro-Electric Plant. P. Frenell. Illustrated description of features of interest in the Hemsjö plant, showing the advantage of storage of water. 4500 w. Elec Wld—Jan. 7, 1909. No. 1667.

Dalmatian Carbide Works Using 30,000-Volt Generator. Frank Koester. Illustrated detailed description of the Manojlovac power plant, Dalmatia. 2800 w. Elec Rev, N Y—Jan. 9, 1909. No. 1657.

A 50000-Volt Transmission System. Frank C. Perkins. The Brusio-Campocologna, the largest hydro-electric plant in Switzerland is illustrated and described. 2000 w. Sci Am Sup—Jan. 9, 1909. No. 1647.

See also Cofferdams, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Isolated Plants.

The Model Operation of an Isolated Plant. Illustrated detailed description of the method of operating the mechanical plant of the St. Regis Hotel, New York City; the cost records and efficiency. 2500 w. Elec Age—Jan., 1909. No. 1862.

Engines for Isolated Lighting and Power Plants. Charles L. Hubbard. Discusses the best type of engines to be used for such plants. 1600 w. Elec Rev, N Y—Jan. 23, 1909. No. 2017.

Manufacturers' Interests in Isolated Plants. Charles M. Ripley. A defense of independent power plants as compared with Central stations from the standpoint of operating costs. 3500 w. Ir Age—Jan. 7, 1909. No. 1497.

The New Power Plant of Pacific Mills. Illustrated description of the steam turbine-generator installation at Lawrence, Mass. Mills for the manufacture of textile goods. 2000 w. Elec Rev, N Y—Jan. 2, 1909. No. 1467.

Operation.

Parallel Operation of Turbine-Driven Central Stations. J. E. Fries. Explains the function of the turbine speed regulator, giving examples of arrangements for different conditions. 2000 w. Elec Rev, N Y—Jan. 9, 1909. No. 1659.

Rates.

Rate Regulation of Electric Power. S. S. Wyer. Discusses the legal principles involved in the sale of electricity. 6500 w. Cassier's Mag—Jan., 1909. No. 1727 B.

Central Station Rates. Abstract of paper by R. S. Wallace, at meeting of the Illinois State Elec. Assn., on "Rates and Their Relation to the Cost of Manufacture." 3500 w. Elec Wld—Jan. 7, 1909. No. 1671

Switch Bars.

See Switches, under DISTRIBUTION.

Taxation.

The Proposed Electricity Taxation Law and Electric Lighting (Der Entwurf des Elektrizitätssteuergesetzes in technischer Beleuchtung). Georg Dettmar. A discussion of the probable effects of the law proposed in Germany. Discussion. Ills. 25000 w. Elektrotech Zeitschr—Dec. 10, 1908. No. 2111 D.

Wind Power.

Wind Power for Driving Dynamos (Utilisation du Vent comme Force Motrice pour Actionner des Dynamos). J. A. Montpellier. A discussion of the cost of wind power plants. 2000 w. L'Elecn—Dec. 5, 1908. No. 1920 D.

LIGHTING.

Arc Lamps.

The Relation Between the Efficiency of Alternating-Current Flame Arc Lamps and the Nature and Amount of the Steadying Device (Ueber die Abhängigkeit der Lichtstärke und des Effektverbrauches bei Wechselstrom-Flammbogenlampen von der Art und Grösse der Vorschaltung). Paul Högner. A comparison between induction coils and the resistor in series. Ills. 2000 w. Elek Zeitschr—Dec. 3, 1908. No. 2117 D.

The Dependence of the Efficiency of Alternating-Current Flame Arc Lamps on the Nature and Amount of the Steadying Device. Report of results of recent experiments by Paul Högner. 1200 w. Elec Engr, Lond—Dec. 25, 1908. No. 1517 A.

The Regulation of Arc Lamps with Inclined Electrodes and Deflecting Magnets (Ueber das Regulieren der Bogenlampen mit schrägen Kohlen und Blasmagneten). J. Teichmüller. An explanation of the principles. Ills. Serial. 1st part. 3500 w. Elektrotech Zeitschr—Dec. 17, 1908. No. 2112 D.

Illumination.

Indirect Illumination. Augustus D. Curtis. Illustrates and describes the successful use of tungsten lamps for indirect lighting. 1400 w. Cent Sta—Jan., 1909. No. 1655.

The Lighting of Reading Rooms: With Some Examples. P. Blagg. Criticises the work in English libraries, giving examples of good and bad arrangements. 2500 w. Elec Rev, Lond—Dec. 25, 1908. No. 1519 A.

Incandescent Lamps.

The Incandescent Electric Lamp. J. Findlay. Abstract of a paper read before the Rugby Engng Soc. Remarks on early patents, tests, rating, etc. 1500 w. Elect'n, Lond—Dec. 25, 1908. No. 1522 A.

Metallic Filament Lamps. W. A. Barnes. Abstract of paper before the Manchester Assn. of Engrs. Describes types, giving detailed results of tests, and related information. 2500 w. Prac Engr—Jan. 15, 1909. Serial. 1st part. No. 2051 A.

Standard Lamp Screws of the German Electrical Association and Their Use in Practice (Die Normalgewinde des Verbandes Deutscher Elektrotechniker und ihre Anwendung in der Praxis). Paul A. Perls. A critical discussion. Ills. 3600 w. Elektrotech Zeitschr—Dec. 3, 1908. No. 2110 D.

See also Illumination, under LIGHTING.

Street.

Recent Developments in the Street Lighting of Berlin, and a Comparison with Former Methods of Illumination. Dr. L. Bloch. A detailed comparison of the various methods now in use. 2500 w. Elect'n, Lond—Jan. 1, 1909. Serial. 1st part. No. 1701 A.

A Few Notes on American and European Street Lighting. H. Thurston Owens. A comparison, illustrating and describing fixtures, methods, etc., with suggestions. 2500 w. Eng News—Jan. 7, 1909. No. 1638.

MEASUREMENT.

Dynamo Testing.

On a Method of Using Transformers as Choking Coils and Its Application to the Testing of Alternators. J. D. Coales Abstract of a paper read before the Birmingham Loc. Sec. of Inst. of Elec. Engrs. Describes the method and its application. 1800 w. Elect'n, Lond—Dec. 25, 1908. No. 1521 A.

Instruments.

Alternating-Current Instruments. Paul MacGahan. The present article gives an illustrated description of disc type induction ammeters and voltmeters, their construction and operation. 1800 w. Elec Jour—Jan., 1909. Serial. 1st part. No 1845.

Insulation Testing.

Insulation Testing. E. M. Wood. Deals with tests made to determine if the insulation is sufficient for safe use. 3000 w Ap Sci—Jan., 1909. No. 2094 C.

Meters.

Value of the Care and Maintenance of Meters. H. D. King. Abstract of a paper read before the Nat. Elec. Lgt. Assn. Gives results of tests made of meters. 1000 w. Elect'n, Lond—Dec. 25, 1908. No. 1527 A.

We supply copies of these articles. See page 1071.

Meter Testing.

Testing Electric Meters. From a paper, by Frank A. Vaughn, read before the N.-W. Elec. Assn., giving an account of the measures adopted at Milwaukee to meet the requirements of the Wisconsin public service commission. 1800 w. Elec Wld—Jan. 28, 1909. No. 2128.

Testing and Adjusting Watt-Hour Meters. O. F. Dubruiel. Gives practical methods of handling Westinghouse instruments, with wiring diagrams. 1500 w. Power—Jan. 5, 1909. (Special No.) No. 1481 D.

Power Factor.

Deduction of the Power Factor in Balanced Three-Phase Circuits from Wattmeter Readings (Deduzione del Fattore di Potenza di un Circuito trifase equilibrato dalle Indicazioni dei Wattmetri). Angelo Barbagelata. A mathematical demonstration of the method. Ills. 3600 w. Elettricita—Dec. 3, 1908. No. 1937 D.

Standards.

See Units, under MEASUREMENT.

Units.

Electrical Units and Standards (Unités et Etalons électriques). M. Devaux-Charbonnel. Discusses the problems to be solved in devising an international system. 6000 w. L'Elecn—Dec. 12, 1908. No. 1921 D.

POWER APPLICATIONS.

Agriculture.

Power from the Farm Brook. Donald Cameron Shafer. An illustrated account of the possible uses to be made of electric power generated. 4000 w. Am Rev of Revs—Jan., 1909. No. 1737 C.

Alternating Currents.

Alternating Currents and Reciprocating Movements (Appareils et Machines à Courant et Mouvement alternatifs). P. Boucherot. Discusses the possibility of producing reciprocating movements direct from the alternations in a. c. circuits without utilizing rotary motion. Ills. 7500 w. Bul Soc Int des Elecns—Dec., 1908. No. 1907 F.

Welding.

See same title, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

TRANSMISSION.

Alternating Currents.

Graphical Diagram for Power in an Alternating-Current Circuit. J. Irving Brewer. An explanation of its construction. 1200 w. Elec Wld—Jan. 21, 1909. No. 1871.

The Development of an Alternating-Current Distributing System. H. B. Gear. Discusses problems common to the development of all a. c. systems and also some special cases. Discussion. Ills. 7000 w. Jour W Soc of Engrs—Dec., 1908. No. 1858 D.

Balancing.

The Balancing of a Three-Wire Direct-Current Network. B. Sankey. Suggestions from the writer's experience, describing a successful system. 600 w. Elec Rev, Lond—Jan. 1, 1909. No. 1694 A.

Cable Drawing.

See Conduits, under TRANSMISSION.

Cable Records.

Plans and Records for Electrical Distribution Systems. J. W. Beauchamp. Abstract of a paper before the Leeds Loc. Sec. of the Inst. of Elec. Engrs. Describes the system of mains, records used by the Sheffield Corporation. Diagrams. 1200 w. Elect'n, Lond—Jan. 1, 1909. No. 1697 A.

Circuit Breaking.

Voltage Strains Due to Circuit-Breaking in Direct-Current Systems. L. Silberberg. A mathematical examination of the behavior of voltage and current to ascertain what strains a circuit may undergo during the opening period. 1500 w. Elec Wld—Jan. 7, 1909. No. 1668.

Conduits.

Underground Lines. H. B. Gear and P. F. Williams. Illustrated description of method of installing underground cables in America. 5000 w. Elec Age—Jan., 1909. No. 1863.

Four Wire.

Three-Phase Four-Wire Systems. K. Faye-Hansen. Explains the advantages of this system under certain conditions, and matters relating to its installation. Diagrams. 1200 w. Elect'n, Lond—Dec. 25, 1908. No, 1523 A.

Frequency.

The Influence of Frequency on the Equipment Circuits of Alternating-Current Transmission Lines. A. E. Kennelly. Presents the computed values of resistances, reactances, inductances and capacities of a particular type of transmission-line for different frequencies. 3000 w. Elec Wld—Jan. 21, 1909. No. 1869.

Insulators.

Insulation of High-Tension Transmission Lines. F. S. Denneen. Discusses line insulators and their design. 2500 w. Elect'n, Lond—Jan. 15, 1909. No. 2070 A.

The Electrical Qualities of Porcelain, with Special Reference to Dielectric Losses. H. F. Haworth. Abstract of a paper read before the Royal Soc. Gives particulars of experiments made to determine the capacity, conductivity and dielectric loss of porcelain and their variations in respect to potential, temperature and time. 2500 w. Elect'n, Lond—Jan. 1, 1909. No. 1699 A.

Lightning.

Divisch, a Lightning-Rod Pioneer, 1754. Brother Potamian. An account of early experimental work. 4000 w. Elec Wld—Jan. 2, 1909. No. 1473.

The Theory of Lightning. Daniel S. Carpenter. A study of the accumulation

of electricity on the clouds and its close association with the formation of raindrops is given in the present number. 2500 w. Elec Wld—Jan. 7, 1909. Serial. 1st part. No. 1670.

Line Design.

Chart for the Consultation of the Size of Copper Conductors in Transmission Lines. L. A. Herdt. Chart with explanation of its construction and use. 2000 w. Elec Wld—Jan. 2, 1909. No. 1474.

The Design of Aerial Transmission Lines (Zur Berechnung offener elektrischer Leitungen). J. K. Sumec. A mathematical discussion of various methods. Ills. 4000 w. Elektrotech u Maschinenbau—Dec. 27, 1908. No. 1995 D.

Lines.

A Spanish Power Transmission Plant at 6600 Volts. Brief illustrated description of a high pressure, long distance system of interest. 500 w. Elec Rev, Lond—Jan. 15, 1909. No. 2062 A.

Line Troubles.

The Winter Sleet Storm as a Destroyer of Aerial Lines. Clarence Mayer. An illustrated account of troubles caused by a sleet storm, and the cost. 1500 w. Elec Rev, N Y—Jan. 16, 1909. No. 1758.

Rotary Converters.

Representation of Synchronous Converter Phenomena. Olin J. Ferguson. Gives a graphical method of representing the converter's behavior. 1200 w. Elec Wld—Jan. 21, 1909. No. 1870.

Substations.

Large New Substations of the Chicago Railways Company. Drawings and description of construction details. 1000 w. Elec Ry Jour—Jan. 2, 1909. No. 1433.

Three-Wire.

The Three-Wire System with One Dynamo. Cecil P. Poole. Explains why the neutral wire is needed; methods used for compensating unbalanced load, etc. Ills. 1500 w. Power—Jan. 5, 1909. (Special No.) No. 1485 D.

See also Balancing, under TRANSMISSION; and Conductors, under STREET AND ELECTRIC RAILWAYS.

Transformers.

Transformers. W. B. Kouwenhoven. Explains the principle upon which a transformer operates. 2500 w. Ry & Loc Engng—Jan., 1909. No. 1448 C.

Chart for Determining the Efficiencies of Transformers. Henry C. Stanley. Gives chart for determining efficiencies at ¼ load intervals from ¼ load to 1¼ load. 500 w. Elec Wld—Jan. 2, 1909. No. 1475.

Tests of a 100,000-Volt Transformer (Versuche mit 100,000 Volt-Transformatoren). Gustav Benischke. Describes the tests and discusses the results. Ills. 1800 w. Elek Kraft u Bahnen—Dec. 4, 1908. No. 1989 D.

See also Dynamo Testing, under MEASUREMENT.

Underground.

See Conduits, under TRANSMISSION.

MISCELLANY.

Review of 1908.

A Review of the Year in the Electrical Industry. Brief review of the important divisions of this industry. 6000 w. Elec Rev, N Y—Jan. 2, 1909. No. 1464.

Electrical Engineering, 1908. A review of progress, especially in Great Britain, and applications made. 4000 w. Engr, Lond—Jan. 1, 1909. No. 1715 A.

Review of Electrical Progress in Great Britain During 1908. Albert H. Bridge. A résumé of present conditions of electrical manufacturing, lighting and power. Ills. 2200 w. Elec Rev, N Y—Jan. 2, 1909. No. 1465.

Electrical Developments on the Continent. C. L. Durand. Considers progress made in electric traction, power, electrochemistry, telegraphy and telephony. 2500 w. Elec Rev, N Y—Jan. 2, 1909. No. 1466.

INDUSTRIAL ECONOMY

Co-partnership.

Co-partnership and Unemployment. George N. Barnes. A reply to the article by Sir Benjamin C. Browne, putting forth the labor view of the subject. 3000 w. Engr, Lond—Jan. 8, 1909. No. 1822 A.

Cost Systems.

Systematic Foundry Operation and Foundry Costs. C. E. Knoeppel. This fifth article of a series deals with apportioning costs to production in various classes of work. 4500 w. Engineering Magazine—Feb., 1909. No. 2156 B.

Errors and Difficulties in Fixing Manufacturing Costs. W. M. S. Miller. Gives a practical plan for correct distribution of expenses. 3300 w. Engineering Magazine—Feb., 1909. No. 2162 B.

See also Cost Keeping, under CIVIL ENGINEERING, CONSTRUCTION; and Cost Keeping, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Depreciation.

The Importance of the Depreciation Question in Industry (Die wirtschaftliche Bedeutung der Abschreibungsfrage für der Industrie). C. M. Lewin. A discussion of the practice of writing off a certain amount each year from plant value to cover depreciation. Ills. 2500 w.

We supply copies of these articles. See page 1071.

Zeitschr f Werkzeug—Dec. 15, 1908. No. 1983 D.

Education.

On the Systematic Training of Engineers: Are We Practical? Charles A. Bowman. Urges some acquaintance with practical engineering experience before entering a technical college. 2000 w. Can Engr—Jan. 22, 1909. No. 2015.

The Development of the Mechanical Engineer. George Frederic Stratton. Discusses the advantages of scientific training. 2000 w. Cassier's Mag—Feb., 1909. No. 2329 B.

University Degrees in Engineering. J. A. Fleming. Considers the requirements and object of engineering education, and how far they are being met by British universities. 3500 w. Engng—Jan. 8, 1909. No. 1821 A.

Organization and Management of Trade Schools. John M. Shrigley. Address before the Nat. Soc. for Pro. of Ind. Ed. Gives the experience of the Williamson Free School of Trades in developing journeymen mechanics, the instruction being by exercise work only. 4500 w. Am Mach—Vol. 32. No. 3. No. 1867.

Laboratory Instruction in Mechanical Engineering and the Laboratory of the Aachen Technical School (Der Laboratoriumsunterricht an Maschinenbauschulen und das Maschinenlaboratorium der Kgl. Höheren Maschinenbauschule zu Aachen). Herr Heim. Illustrated description of equipment. 4300 w. Zeitschr d Ver Deutscher Ing—Dec. 12, 1908. No. 2100 D.

Filing Systems.

See Records, under STREET AND ELECTRIC RAILWAYS.

Industrial Betterment.

See Welfare Work, under RAILWAY ENGINEERING, MISCELLANY.

Labor Arguments.

The Shipbuilding Trades' Agreement. Text of the agreement made with the view of settling trade disputes without stoppage of work. Also editorial. 3000 w. Engng—Jan. 15, 1909. No. 2078 A.

Labor Insurance.

Insurance against Unemployment (Les Caisses d'Assurances contre le Chomage). P. Maurice. A general discussion of the problems of unemployment. Ills. Serial. 1st part. 4000 w. Génie Civil—Dec. 5, 1908. No. 1926 D.

Management.

The Organization of Small Engineering Works. W. O. Horsnaill. Shows the importance of cost-keeping, systematic methods of work, etc., in the present number. 2200 w. Mech Wld—Jan. 1, 1909. Serial. 1st part. No. 1529 A.

Increasing Production by the Premium System. T. A. Sperry. Discusses the essentials of a successful system. 5500 w. Am Mach—Vol. 32, No. 5. No. 2257.

Efficiency as a Basis for Operation and Wages. Harrington Emerson. This eighth article of a series discusses the efficiency system in operation. 4000 w. Engineering Magazine—Feb., 1909. No. 2161 B.

See also Drafting Rooms, under MECHANICAL ENGINEERING, MACHINE ELEMENTS AND DESIGN.

Natural Resources.

The Conservation Idea as Applied to the American Society of Mechanical Engineers. M. L. Holman. Presidential address, 1908, discussing plans of this problem. 12500 w. Jour Am Soc of Mech Engrs—Jan., 1909. No. 1849 F.

Our National Resources, Their Conservation and Utilization. John Birkinbine. A discussion of some of these resources and their proper conservation and wise utilization. 7500 w. Jour Fr Inst—Jan., 1909. No. 1846 D.

How May the First Steps in Conservation be Taken? Editorial on the prevention of waste of mineral wealth, giving abstracts of two papers showing the waste in the oil fields. 3000 w. Eng News—Jan. 7, 1909. No. 1641.

Report of the National Conservation Commission and Accompanying Message of President Roosevelt. All the inventory portion of the report, with an abstract of the remainder. 6500 w. Eng News—Jan. 28, 1909. No. 2153.

Panama Canal.

See same title, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Patents.

Notes on Patent Licenses and Manufacturing Agreements. Theodore Rich. Discusses questions arising between patentee and manufacturer, with special reference to engineering and electrical work. 3500 w. Elec Rev, Lond—Jan. 1, 1909. No. 1695 A.

Review of 1908.

Retrospect of the Year 1908. A review of the industrial activity in civil engineering, naval and military, merchant marine, electricity, etc. 6500 w. Sci Am—Jan. 2, 1909. No. 1428.

Trusts.

The State and the Trusts (Staat und Kartelle). Hugo Bonikowsky. Discusses the proposal for state regulation of the trusts in Germany, with special reference to the "kartelle" in the iron industry. 5500 w. Stahl u Eisen—Dec. 9, 1908. No. 1941 D.

Wages.

Rate Fixing Confined to the fixing of rates in the molding and smithy department, and the erecting or assembling departments. 2000 w. Mech Wld—Jan. 8, 1909. No. 1814 A.

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MARINE AND NAVAL ENGINEERING

Battleships.

Progress of Warships and Machinery Under Construction in England. A review of progress made during the last six months. 2200 w. Engr, Lond—Dec. 25, 1908. No. 1543 A.

The Turbine and Reciprocating Engine a Combination for Better All-Around Efficiency in Vessels of War. H. C. Dinger. Suggests a combined arrangement and presents the advantages and disadvantages. 3500 w. Jour Am Soc of Nav Engrs—Nov., 1908. No. 1890 H.

Cruisers.

Description and Official Trials of the U. S. S. Salem. C. B. Edwards. Ills. 3000 w. Jour Am Soc of Nav Engrs—Nov, 1908. No. 1892 H.

U. S. Armored Cruiser Montana. William Russell White. Illustration, with description of machinery and report of the official trial. 14500 w. Jour Am Soc of Nav Engrs—Nov., 1908. No. 1889 H.

The Siamese Revenue Cruiser. Illustrated description of a vessel to be used for the suppression of the practice of opium and fire-arms smuggling in Siam. 700 w. Engng—Jan. 15, 1909. No. 2077 A.

Ferryboats.

A Unique Ferryboat. Illustration, with brief description of an elevating vehicular ferry steamer for service in Glasgow harbor. 600 w. Int Marine Engng—Jan., 1909. No. 1598 C.

Fire Boats.

Modern Fire-Boats. O. H. Caldwell. Illustrated description of the new electrically propelled and controlled fire-boats for the city of Chicago. 2000 w. Elec Rev, N Y—Jan. 2, 1909. No. 1468.

Gas Engines.

The Gas Engine and Producer Plant and Its Adaptability for Marine Work. E. Shackleton. Considers the objections to such plants, and describes a gas plant of the suction type having four generators. 4000 w. Mech Engr—Dec. 25, 1908. No. 1507 A.

Model Basins.

The Development and Present Status of the Experimental Model Towing Basin. Reviews the steps that led to the establishment of these tanks, and describes existing tanks and their operation. 2000 w. Int Marine Engng—Jan., 1909. No. 1600 C.

Port Holes.

Round Port Holes (Runde Schiffs-Seitenfenster). Rudolf Sodemann. A discussion of materials, cost, and construction. Ills. 2800 w. Schiffbau—Dec. 9, 1908. No. 1962 D.

Propellers.

Recent Screw-Propeller Design. Notes the important investigations made of the efficiency of screw propellers, discussing features of design demanding attention to meet recent conditions. Ills. 2000 w. Int Marine Engng—Jan., 1909. No. 1596 C.

Review of 1908.

The World's Shipbuilding. A review of the year 1908. 2000 w. Engng—Jan. 15, 1908. No. 2076 A.

Shipbuilding and Marine Engineering in 1908. A review of the year's work in British shipyards. 10000 w. Engng—Jan. 1, 1909. No. 1710 A.

Sailing Vessels.

The American Sailing Ship. George L. Norton. Illustrates and describes interesting examples of sailing craft. 2000 w. Int Marine Engng—Jan., 1909. No. 1597 C.

Ship Building.

See Review of 1908, under MARINE AND NAVAL ENGINEERING.

Ship Design.

Decrease in the Weight of Ships Through Change in the Regulations of the German Lloyd (Verminderung des Schiffsgewichts durch die Vorschriften des Germanischen Lloyd 1908). Fr. Jappe. Compares the old and new regulations with regard to the change in weight of certain parts of ships. Ills. 2500 w. Schiffbau—Dec. 9, 1908. No. 1961 D.

See also Steamships, under MARINE AND NAVAL ENGINEERING.

Ship Stability.

A Simple Method for the Rapid Determination of the Transverse Stability of Ships (Ein einfaches Verfahren zur raschen Bestimmungen der Querstabilität eines Schiffes). Herr Ulffers. Ills. 2000 w. Schiffbau—Dec. 23, 1908. No. 1963 D.

Ship Vibratons.

Ship Vibrations (Schiffsschwingungen höherer Ordnung). W. Thele. Discusses their cause, etc. Ills. 3800 w. Zeitschr d Ver Deutscher Ing—Dec. 26, 1908. No. 2108 D.

Steam Engines.

Emergency Repairs at Sea. P. J. Giron. Illustrates and describes examples taken from actual experience. 800 w. Prac Engr—Dec. 25, 1908. Serial. 1st part. No. 1514 A.

Steamships.

A Longitudinally-Framed Ship. Benjamin Taylor. Illustrated description of the oil tank steamer Paul Paix, constructed on the Isherwood system. 1200 w. Int Marine Engng—Jan., 1909. No. 1599 C.

We supply copies of these articles. See page 1071.

The Rathmore. Illustrated detailed description of a fine new passenger steamship in service of the London and Northwestern Railway between Holyhead and Greenore. 2 plates. 2000 w. Engr, Lond—Jan. 15, 1909. No. 2081 A.

Submarines.

The Italian Submersible Boat "Otaria." Brief illustrated description. 400 w. Engng—Jan. 1, 1909. No. 1707 A.

Progress in Submarine Craft. Robert C. Skerrett. Information concerning British, French and Italian developments and general statistics. 1800 w. Ir Age—Jan. 7, 1909. No. 1493.

Submarine Signalling.

Electrically-Operated Submarine Bells. Illustrates and describes bells installed by the French Service des Phares. 800 w. Engr, Lond—Jan. 1, 1909. No. 1712 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Carbureters.

The Formation of Gasoline Air Mixtures. Discusses vaporization and the considerations affecting it. 5000 w. Automobile—Dec. 31, 1908. No. 1458 C.

Commercial Vehicles.

The Commercial Truck vs. the Horse. Benjamin Rogers. Information in regard to expense of operation, advantages, etc. 1500 w. Sci Am—Jan. 16, 1909. No. 1775.

See also Omnibuses, under AUTOMOBILES.

Construction.

How to Convert a Horse-drawn Buggy Into a Motor Buggy for Less than $300. George Heron. Illustrated detailed description of the work. 1500 w. Sci Am—Jan. 16, 1909. No. 1780.

Electric.

Electric Automobiles (Ueber Elektromobile). E. Sieg. Gives a historical review of their development and discusses the various systems. Ills. Serial. 1st part. 1800 w. Elektrotech Zeitschr—Dec. 24, 1908. No. 2114 D.

Exhibitions.

Level on Which Merit Stands Is Congested. Thomas J. Fay. Calls attention to marks of progress evident in the exhibits at the Palace exhibition in New York. Ills. 2500 w. Automobile—Jan. 7, 1909. No. 1591.

The Mechanical Lesson of the Palace. Thomas J. Fay. A general review of the exhibits at the Grand Central Palace, New York City. Ills. 7500 w. Automobile—Dec. 31, 1908. No. 1457 C.

France.

The Automobile Crisis in France (La Crise automobile en France). E. Girardault. Discusses the causes and probable results of the present unsatisfactory state of the automobile industry. Ills. 3300 w. Génie Civil—Dec. 19, 1908. No. 1930 D.

Fuel Storage.

The Storage of Combustible Liquids (Die Lagerung feuergefahrlicher Flüssigkeiten). Discusses the precautions necessary in handling and storing combustible liquids and describes appliances for the purpose. Ills. 6000 w. Oest Wochenschr f d Oeffent Baudienst—Dec. 5, 1908. No. 1975 D.

Ignition.

High Tension Ignition by Magneto. Roger B. Whitman. Illustrates and describes typical magnetos used in American cars. 3000 w. Sci Am—Jan. 16, 1909. No. 1776.

Imperia.

The Imperia Petrol Cars. Illustrated description of a 16-20 h.p. car built in Belgium. 1000 w. Auto Jour—Dec. 26, 1908. No. 1505 A.

Lamps.

What Lamp Should a Motorist Buy? The Candle-Powder Problem. An explanation of phenomena produced by light. Diagrams. 1600 w. Auto Jour—Jan. 16, 1909. Serial. 1st part. No. 2048 A.

Lubrication.

Automobile Lubrication.—Some Elementary Principles. Thomas D. Hanauer. The importance of systematic lubrication, lubricants, and related subjects are discussed. Ills. 3500 w. Sci Am—Jan. 16, 1909. No. 1778.

Metallurgique.

The 12-H.P. Metallurgique Car. Illustrated description of a two-passenger car shown at Olympia. 700 w. Auto Jour—Jan. 9, 1909. No. 1799 A.

Motor Cooling.

The Effect of Glycerine on the Cooling Water of an Engine. Henry O'Connor. Gives report of an investigation which showed no effect on the cooling power below 180°. 600 w. Autocar—Jan. 2, 1909. No. 1685 A.

Motors.

The Two-Cycle Automobile Motor. E. W. Roberts. Illustrates and describes types, explaining the term. 2000 w. Sci Am—Jan. 16, 1909. No. 1779.

The Ultimate Internal Combustion Motor and Its Probable Fuel. Thomas L. White. Calls attention to new lines of research and the present outlook. 1800 w. Ir Age—Jan. 7, 1909. No. 1494.

Omnibuses.

The Use of the Motor Omnibus in Eu-

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rope. Information from a report by Mr. Mauclere, presented at the Munich Congress of the Int. Union of St. Rys. & Light Rys. 1500 w. Eng News—Dec. 31, 1908. No. 1406.

Progress in the Construction of Motor Omnibuses and Heavy Motor Trucks (Fortschritte im Bau von Motoromnibussen und schweren Motorlastwagen). A. Heller. Illustrated description of various recent types. Serial. 1st part. 4000 w. Zeitschr d Ver Deutscher Ing—Dec. 5, 1908. No. 1998 D.

Road Trains.

The Renard Road and Rail Transport Corporation, Limited. A letter giving a report of trials in India. 2500 w. Min Jour—Jan. 16, 1909. No. 2065 A.

Straker-Squire.

The 1909 14-16 H. P. Straker Squire. Illustrated description. 1500 w. Autocar—Dec. 26, 1908. No. 1504 A.

Tires.

Our Legion Tires and Their Troubles. Orrel A. Parker. Discusses types of tires and their troubles, the effect of proper and improper driving, the importance of selecting tires suitable for the kind of service, etc. Ills. 4000 w. Sci Am—Jan. 16, 1909. No. 1777.

Detachable and Demountable Rims Discussed. Hermann F. Cuntz. Discusses what is being done in this field as a solution of the problem of quickly replacing tires. 1100 w. Automobile—Jan. 21, 1909. No. 1897.

Tractors.

Modern Steam Tractors for Rapid and Light Road Haulage Purposes. William Fletcher. An illustrated article dealing with mechanical haulage on common roads. 4000 w. Cassier's Mag—Jan., 1909. No. 1726 B.

Westinghouse.

The 20-30 H. P. Westinghouse. Illustrates and describes details of the chassis. 1500 w. Autocar—Jan. 9, 1909. No. 1800 A.

COMBUSTION MOTORS.

Fuels.

The Properties of Liquid Fuels. E. B. Norris. A study of the methods of using liquid fuels. 3000 w. Engr, Pa—Dec., 1908. No. 2009 D.

Gas Dangers.

Dangers of Water Gas, Suction Gas, and Other Gases in Factories. Memorandum issued by the Factory Department of the Home Office, giving the causes of such accidents and the best means for their prevention. 3000 w. Mech Engr—Jan. 8, 1909. No. 1811 A.

Gas Engines.

Gaseous Explorations. First report of the Committee appointed by the British Association to investigate gaseous explosions, with special reference to temperature. 5000 w. Mech Engr—Jan. 1, 1909. Serial. 1st part. No. 1512 A.

Gas Engine Compression and Efficiency. Paul C. Percy. Explains why the degree of compression affects the efficiency and economy. 2000 w. Power—Jan. 5, 1909. (Special No.) No. 1488 D.

See also Crank Shafts, under MACHINE ELEMENTS AND DESIGN; and Gas Engines, under MARINE AND NAVAL ENGINEERING.

Gas Power Plants.

The Gas Power Plant at the Swift Warehouse in New York. Illustrated description. 2200 w. Eng Rec—Jan. 16, 1909. No. 1765.

Utilizing Blast-Furnace Gases at Gary. Describes a plant to be operated by gases formerly considered waste. 3000 w. Eng & Min Jour—Jan. 2, 1909. No. 1441.

Bituminous Gas-Producer Electrical Generating Plant. Elbert A. Harvey. Illustrated description of the plant of the Garford Company, Elyria, Ohio. 1000 w. Elec Wld—Jan. 2, 1909. No. 1471.

Gas Producers.

The Physical Theory of Coal Carbonization. W. H. Fulweiler. Read before the Am. Gas Inst. Brief review of the development, describing methods of carbonization used, and related matters. 10700 w. Am Gas Lgt Jour—Jan. 4, 1909. Serial. 1st part. No. 1395.

Notes on Anthracite Producer Practice. George C. Stone. An account of experiments made in the effort to improve practice. 1200 w. Jour Ind & Engng Chem—Jan., 1909. No. 2039 E.

Bituminous Producer Plants. Elbert A Harvey. Abstract of paper, with discussion. 6500 w. Jour Am Soc of Mech Engrs—Jan., 1909 No. 1854 F.

Operation of Induced Draft and Suction Producers. Frank P. Peterson. Discusses the danger of explosion, and the use of flame arresters. 2000 w. Power—Jan. 5, 1908. (Special No.) No. 1486 D.

Ignition.

Getting Acquainted with the Jump-Spark. Herbert L. Towle. Diagrams and explanatory notes. 3500 w. Rudder—Jan., 1909. No. 1502 C.

Oil Engines.

The Employment of Hydrocarbon Extracts from Petroleum, Bituminous Shales and Coal in Combustion Motors (Emploi des Hydrocarbures extraits des Pétroles, des Schistes et de la Houille dans les Moteurs à Explosion). A. Grebel. Discusses the advantages of liquid fuels, resources of France in mineral oils, etc. 4400 w. Génie Civil—Dec. 26, 1908. No. 1932 D.

HEATING AND COOLING.

Central Plants.

See Hot-Water Heating, under HEATING AND COOLING.

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Electric Heating.

The Relative Advantages of Coal, Gas and Electric Heating (Güteverhältnis zwischen Kohlen-, Gas- und elektrischer Heizung). M. Grellert. A reply to E. R. Ritter's article on electric heating, showing the comparative cheapness of gas. 2800 w. Gesundheits-Ing—Dec. 12, 1908. No. 1967 D.

Hot-Air Heating.

Heating a Montreal Church. Describes an indirect gravity system supplemented by a fan. Ills. 2500 w. Met Work—Jan. 16, 1909. No. 1755.

See also Shop Heating, under MACHINE WORKS AND FOUNDRIES.

Hot-Water Heating.

Design of Hot-Water Heating Systems with Reference to Heat Loss in Pipe Lines (Die Berechnung der Warmwasserheizung unter Berücksichtigung der Wärmeverluste der Rohrleitungen). Dr. Rietschel. Discusses both single and double pipe systems. Ills. 10000 w. Gesundheits-Ing—Dec. 19, 1908. No. 1969 D.

A Comparison Between the Single- and Double-Pipe Hot Water Heating Systems (Ein Vergleich zwischen dem Einrohr- und dem Zweirohrsystem der Warmwasserheizung). H. Roose. Supports the single-pipe system. 2000 w. Gesundheits-Ing—Dec. 5, 1908. No. 1965 D.

Heating by Hot Water Under Pressure (Ueber Druckwasserheizung). Anton Gramberg. An exhaustive discussion of this new method. Ills. Serial. 1st part. 9300 w. Gesundheits-Ing—Dec. 26, 1908. No. 1970 D.

Distant Hot-Water Heating (Fernwarmwasserheizung). Dr. Rietschel. Discusses central plants and distribution systems. Ills. 6600 w. Gesundheits-Ing—Dec. 19, 1908. No. 1968 D.

Domestic and Circulating Hot-Water Boilers. Remarks on their general management and means of preventing explosions, taken from W. H. Fowler's work on steam boilers. Ills. 2000 w. Mech Engr—Jan. 8, 1909. No. 1810 A.

A Large Residence Hot Water Heating System. Plans and description of an interesting system installed at Bernardsville, N. J. 800 w. Met Work—Jan. 2, 1909. No. 1398.

See also Boiler Rating, under STEAM ENGINEERING.

Pipe Corrosion.

Relative Corrosion of Wrought Iron and Steel Pipes. Report of tests made by the Committee appointed by the Am. Soc. of Heat. & Vent. Engrs. 1500 w. Heat & Vent Mag—Jan., 1909. No. 1887.

Refrigeration.

The Uses of Mechanical Refrigeration in Metallurgical Practice. Jos. H. Hart. Discusses its value in increasing furnace output and condensing by-products. 2000 w. Engineering Magazine—Feb., 1909. No. 2157 B.

The Compression Refrigerating System. F. E. Matthews. An explanation. 2500 w. Power—Jan. 5, 1909. (Special No.) No. 1487 D.

Air Cooling by Refrigeration. W. W. Macon. Discusses how to determine the requirements of refrigerating apparatus needed. 6500 w. Heat & Vent Mag—Jan., 1909. No. 1888.

Practical Hints. William Westerfield. Suggestions on the application of the indicator to ammonia compressors. 2500 w. Ice & Refrig—Jan., 1909. No. 1456 C.

Steam Heating.

Heating and Ventilation of the Union Terminal Station at Washington, D. C. Illustrated description of the heating and ventilating facilities for the head-house. 3500 w. Eng Rec—Jan. 2, 1909. No. 1426.

See also Boiler Rating, under STEAM ENGINEERING.

Ventilation.

Ventilation of Three Basement Floors of the Marshall Field Retail Store, Chicago. Illustrated description of method adopted for ventilating three stories below the street level. 2000 w. Eng Rec—Jan. 23, 1909. No. 2022.

See also Steam Heating, under HEATING AND COOLING; and Tunnel Ventilation, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

Steam Turbo High-Lift Pump. Illustrates and describes a large centrifugal pump operated by a steam turbine constructed for the Montreal Water & Power Co. 1500 w. Engr, Lond—Dec. 25, 1908. No. 1545 A.

Results of Tests on a Low-Head Centrifugal Pump (Besprechung von Versuchsergebnissen einer niederdruck-Kreiselpumpe). Johannes Bente. Gives the results in tabular form and draws conclusions from them. Ills. 1600 w. Die Turbine—Dec. 5, 1908. No. 1958 D.

See also Water, under MEASUREMENT.

Discharge Coefficients.

See same title, under CIVIL ENGINEERING, WATER SUPPLY.

Pumping Plants.

See Irrigation, under CIVIL ENGINEERING, WATER SUPPLY.

Surge Tanks.

The Surge Tank in Water Power Plants. R. D. Johnson. Abstract of paper with continued discussion and author's closure. 9000 w. Jour Am Soc of Mech Engrs—Jan., 1909. No. 1855 F.

Turbine Governors.

See Operation, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

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Turbine Plants.

Recent Turbine Plants (Neuere Turbinen-Anlagen). Wilhelm Müller. Illustrated description of a number of plants with special reference to high speed and methods of governing. Serial, 1st part. 1300 w. Die Turbine—Dec. 20, 1908. No. 1960 D.

Turbines.

A Comparison of American High Speed Runners for Water Turbines. S. J. Zowski. Aims to show how far American manufacturers have progressed in the attempt to secure high speed and high capacity simultaneously and to compare the results of respective runner types. Ills. 4000 w. Eng News—Jan. 28, 1909. No. 2151.

The Schulz Turbine (Die Schulz-Turbine). Herr Forst. Illustrated description, test results, etc. Serial, 1st part. 1600 w. Die Turbine—Dec. 5, 1908. No. 1959 D.

See also Water, under MEASUREMENT.

MACHINE ELEMENTS AND DESIGN.

Brakes.

See same title, under ELECTRICAL ENGINEERING, DYNAMOS AND MOTORS.

Clutches.

Clutches (Quelques Embrayages). Illustrated detailed description of a large number of recent devices. 5000 w. Rev de Mécan—Dec., 1908. No. 2103 E + F.

Crank Shafts.

Crank Shafts for Gas Engines. Horace Allen. Discusses methods of providing for the special stresses. Diagrams. 1500 w. Cassier's Mag—Jan., 1909. No. 1730 B.

Drafting Rooms.

Some Items of Drawing-Office System. W. Lawrence. Suggests items that may save time and tend to efficiency. 2000 w. Elec Rev, Lond—Dec. 25, 1908. No. 1518 A.

Drawings.

An Important Possibility in Working-Drawings. Describes the advantages of a method of photographic reduction. 2500 w. Eng News—Jan. 28, 1909. No. 2152.

Flywheels.

The Design of Rapidly Rotating Fly Wheels (Zur Berechnung schnellaufender Scheibenräder). Herr Roemmelt. Mathematical. Ills. 5000 w. Elek Kraft u Bahnen—Dec. 4, 1908. No. 1988 D.

Hobs.

How Many Gashes Should a Hob Have? Ralph E. Flanders. Studies the imperfect generating action of the hob, giving diagrams for finding the number of cuts per linear pitch, and discussing the effect of the number of teeth in the wheel. 2000 w. Mach, N Y—Jan., 1909. No. 1550 C.

Levers.

Rolling Levers (Wälzhebel). Heinrich Holzer. A theoretical study of their design. Ills. 6500 w. Zeitschr d Ver Deutscher Ing—Dec. 19, 1908. No. 2105 D.

Riveted Joints.

Calculating Strength of Riveted Joints; How to Use Riveted Joint Diagrams. S. F. Jeter. Two articles, the first giving elaborate diagrams for calculating the strength of joints and the second simple instructions for and illustrations of their use. Ills. 8500 w. Power—Jan. 5, 1909. (Special No.) No. 1482 D.

Speed Variation.

See Electric Driving, under POWER AND TRANSMISSION.

Springs.

Helical Springs. Henry L. Hanson. Gives tables showing the greatest allowable pressure or load in pounds, and the corresponding compression or deflection in inches per coil of helical springs of various sizes, with examples and explanations. 1000 w. Supplement. Mach, N Y—Jan., 1909. No. 1551 C.

The Deflection of Rotating Springs (Die Durchbiegung rotierender Schraubenfedern). M. Tolle. A mathematical discussion. Ills. 3200 w. Zeitschr d Ver Deutscher Ing—Dec. 12, 1908. No. 2101 D.

Thrust Bearings.

Thrust Bearings. G. B. Woodruff. Read at the Inst. of Marine Engrs. Specially describing a new form of thrust bearing said to give results, as regards load-carrying capacity and low friction loss, similar to those of a perfectly lubricated journal bearing. Ills. 3500 w. Can Engr—Jan. 1, 1909. No. 1399.

MACHINE WORKS AND FOUNDRIES.

Automatic Machinery.

Automatic Metal Bottle Cap Machinery. Illustrated description of an automatic equipment for the rapid production of a two-piece bottle-cap. 1500 w. Ir Age—Jan. 7, 1909. No. 1492.

Brass Founding.

See Alloys, under MATERIALS FOR CONSTRUCTION.

Castings.

The Scientific Mixing of Iron for Castings. George Hailstone. Abstract of paper read before the Staffordshire Iron and Steel Inst. Discusses the scientific organization involved in the production of molten iron for castings. 5000 w. Ir & Coal Trade Rev—Dec. 24, 1908. No. 1546 A.

New Method of Making Steel Castings. E. F. Lake. An illustrated article giving information of the kinds of steel used and intricate shapes cast by a shop in Germany. 1500 w. Am Mach—Vol. 31, No. 53. No. 1403.

Manufacture of Steel Castings in Small Quantities. Arthur Simonson. Read before the Phila. Found. Assn. Using a converter of 1000 pounds capacity, by the

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new Tropenas system. Ills. 2500 w. Ir Trd Rev—Jan. 14, 1909. No. 1753.

Defective Castings. G. E. Lines. Discusses the work of the different departments of the foundry showing that the responsibility lies with no one department. Ills. 1800 w. Mech Wld—Jan. 1, 1909. Serial, 1st part. No. 1528 A.

Sponginess on the Upper Surface of Castings. D. Wilkinson, Junr. Describes this and other defects in castings, considering the causes and remedies. 2000 w. Ir & Coal Trds Rev—Jan. 8, 1909. No. 1830 A.

Steel Foundry Shrinkage Problems. R. A. Bull. A discussion of causes of shrinkage and methods of overcoming them. 4000 w. Foundry—Jan., 1909. No. 1613.

See also Electro-Metallurgy, under MINING AND METALLURGY, IRON AND STEEL.

Cupolas.

Cupola Practice. M. Albütz. Compares statements in papers by Mr. Bellamy and by Mr. Dalrymple, and also other investigators. 4500 w. Ir & Coal Trds Rev—Dec. 24, 1908. No. 1548 A.

A Suggested Change in Cupola Practice. Richard Moldenke. Read before the Phila. Found. Assn. Describes an improved method of charging, discussing related matters. 3000 w. Foundry—Jan., 1909. No. 1615.

Forging Presses.

German Friction-Spindle Presses. I. W. Chubb. Illustrated description. 600 w. Am Mach—Vol. 32. No. 4. No. 2138.

Foundries.

Casting Tramway Crossings. Illustrates and describes a small foundry plant for this purpose at Manchester, Eng. 700 w. Engr, Lond—Jan. 8, 1909. No. 1827 A.

Foundry Management.

Problems of a Congested Foundry. An Illustrated explanation of how they were solved at the Allegheny plant of the Westinghouse Co. 3500 w. Foundry—Jan., 1909. No. 1610.

Foundry Practice.

Repetition Work in Small Quantities. C. Buchanan. Explains a simple match plate process which can be used economically. 2000 w. Foundry—Jan., 1909. No. 1611.

The Use of Chills in Iron Founding (Die Verwendung von Kokillen in der Eisengiesserei). E. Leber. A general discussion of their uses and applications. Ills. Serial, 1st part. 2000 w. Stahl u Eisen—Dec. 2, 1908. No. 1940 D.

Gear Cutting.

The Cutting of Elliptic Gears. Warren E. Thompson. Describes the process. Ills. 900 w. Am Mach—Vol. 32. No. 4. No. 2140.

A Hobbing Cutter for Finishing Wheels. P. A. Thompson. Illustrates and describes a special finishing hob. 1200 w. Am Mach—Vol. 32. No. 4. No. 2136.

See also Hobs, under MACHINE ELEMENTS AND DESIGN.

Grinding Machines.

The New Bath Grinders. Illustrated detailed description of the new universal grinder known as No. 2½. 2500 w. Ir Age—Jan. 28, 1909. No. 2120.

German Designs of Internal Grinding Machines. Oskar Kylin. Illustrates and describes grinding machines for special purposes. 1000 w. Mach, N Y—Jan., 1909. No. 1554 C.

Automatic Machine for Rectifying and Grinding Hobs for Cutting Gear Wheels. Illustrates and describes the invention of Marcel Lejeune. 500 w. Prac Engr—Dec. 25, 1908. No. 1513 A.

See also Lathes, under MACHINE WORKS AND FOUNDRIES.

Lathes.

Multiple Turning and Grinding Shafting Lathe. Illustrated description. 800 w. Engng—Dec. 25, 1908. No. 1539 A.

A Lathe Converted Into a Cylinder Grinder. M. E. Dawson. Line drawings and description. 800 w. Am Mach—Vol. 32. No. 3. No. 1866.

Lathe Chuck and Chuck-Operating Mechanism. Illustrates and describes a mechanism especially applicable to lathes used in finishing small articles, 1200 w. Mech Engr—Jan. 1, 1910. No. 1511 A.

The Whitcomb-Blaisdell Cushion Clutch Geared Head Lathe. Illustrated description of a new single pulley drive all-geared friction head engine lathe designed for a wide range of usefulness. 1800 w. Ir Age—Dec. 31, 1908. No. 1396.

Milling.

Milling Fixtures Used in a Russian Shop. J. W. Carrel. Illustrated description of devices and methods used in the manufacture of cigarette machines. 300 w. Am Mach—Vol. 32. No. 1. No. 1622.

Milling Cutters.

A New High Speed Milling Cutter. William H. Taylor. Illustrates and describes the development of an inserted blade cutter giving remarkable results. 3500 w. Am Mach—Vol. 32. No. 1. Serial, 1st part. No. 1619.

Molding Machines.

A New Rock-Over Molding Machine. Illustrated description of a machine for molding stove plates. 1500 w. Foundry—Jan., 1909. No. 1616.

Wilkinson's Pattern-Plate Moulding Machine. Illustrated description of an appliance for moulding plate patterns. 500 w. Engng—Dec. 25, 1908. No. 1538 A.

Patterns.

The Use of an Adjustable Pattern. H. J. McCaslin. Describes the construction of a pattern for molding a cast-steel trav-

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cling crane and carriage of comparatively thin section. Ills. 2000 w. Foundry—Jan. 1909. No. 1612.

Composition and Metal Match Plates. Illustrates and describes methods of making these permanent pattern plates. 4000 w. Foundry—Jan., 1909. No. 1614.

Pipe Making.

The History of Seamless Tubes (Zur Geschichte der nahtlosen Rohren). M. Müller. A review of past and present methods of production. Ills. 3000 w. Stahl u Eisen—Dec. 16, 1908. No. 1943 D.

Planer Drive.

Details of the Mitchell Planer Drive. Illustrated description, explaining the principles. 1800 w. Am Mach—Vol. 32. No. 2. No. 1752.

Planers.

Vertical and Horizontal Planers. W. T. Sears. Illustrates and describes examples of these tools and their applications. 1200 w. Am Mach—Vol. 31. No. 53. No. 1400.

A New 240 x 42 Inch Spur Gear Planer. Illustrated description of a direct driven, simple and effective design. 1200 w. Am Mach—Vol. 32. No. 4. No. 2135.

Polishing.

Finishing Metals by Polishing. Bradford H. Divine. Discusses the considerations governing the art of polishing. 5000 w. Ir Trd Rev—Jan. 28, 1909. Serial, 1st part. No. 2132.

Shop Appliances.

Forming Dies for Railroad Forge Shops. G. M. Steward. Illustrates and describes some of these devices. 600 w. Am Mach—Vol. 32. No. 1. No. 1623.

Shop Design.

Machine Grouping and Factory Layout, as Affecting Cost Data. C. H. Stilson. Discusses the influence of the location of machinery upon factory costs. Ills. 1800 w. Cassier's Mag—Jan., 1909. No. 1725 B.

Shop Heating.

Shop Heating. F. R. Still. Discusses the field of the blower system. 2000 w. Met Work—Jan. 16, 1909. No. 1756.

Shop Lighting.

Notes on Shop Lighting and the Cost of Artificial Illumination (Dispositions générales de l'Eclairage des Ateliers et Dépense de l'Eclairage artificiel). Louis Pichenot. Considers sun light and illumination by oil, electric, gas, and acetylene lamps. 3000 w. Rev d'Econ Indus—Dec. 16, 1908. No. 1900 D.

Shop Practice.

Machine Work in the Rambler Automobile Factory. Ethan Viall. Illustrated description of methods used. 1200 w. Am Mach—Vol. 32. No. 1. No. 1620.

Shops.

Balancing Threshing Machine Cylinders. An illustrated description of a difficult piece of work. 2000 w. Am Mach—Vol. 32. No. 2. No. 1749.

See same title, under RAILWAY ENGINEERING, Motive Power and Equipment.

Shop Whistles.

Blowing the Works Whistle Automatically. Frank Sawford. Illustrates and describes the arrangement. 2000 w. Power—Jan. 26, 1909. No. 2088.

Stamp Making.

The Making of Steel Stamps for the Machinist. P. E. Noyes. Illustrates and describes the tools and methods used. 2200 w. Am Mach—Dec. 31, 1908. No. 1402.

Tap Making.

The Manufacture of Taps. Illustrates and describes methods employed when taps are made in large quantities, describing the works of Wells Bros. Co., at Greenfield, Massachusetts. 5000 w. Mach, N Y—Jan., 1909. Serial, 1st part. No. 1552 C.

Tempering.

Hardening Carbon and High Speed Steel. Warren E. Thompson. Describes methods used by the author. 1600 w. Am Mach—Vol. 32. No. 1. No. 1621.

Barium Chloride for Hardening Steel. Ethan Viall. Illustrated description of the design of furnace, heating and composition of the barium mixture, cost of operation, and results obtained. 1200 w. Am Mach—Jan. 7, 1909. No. 1624.

Welding.

Electric Welding. Illustrated detailed description of machines for electric welding by the Thompson process. 5000 w. Engng—Jan. 15, 1909. Serial, 1st part. No. 2075 A.

Autogenous Welding with Oxy-Acetylene. Henry Cave. Condensed paper read before the Auto. Engrs. of America. Illustrated article describing torches used, methods, etc. 4500 w. Am Mach—Vol. 32. No. 4. No. 2137.

Oxy-Acetylene Welding and Cutting. H. R. Cobleigh. Illustrates and describes the process and some applications. 5000 w. Ir Age—Jan. 7, 1909. No. 1501.

Woodworking Machines.

Universal Dovetailing Machine. Illustrates and describes a new machine for dovetailing boards used for making boxes. 700 w. Engng—Jan. 1, 1909. No. 1709 A.

Wrenches.

Classification and Uses of Wrenches. Hubert E. Collins. On the proper names, uses and abuses of wrenches. Ills. 4500 w. Power—Jan. 5, 1909. (Special No.) No. 1480 D.

Wrench Making.

The Making of Spanner Wrenches. Describes the successive operations. Ills. 1200 w. Mach, N Y—Jan., 1909. No. 1553 C.

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MATERIALS OF CONSTRUCTION.

Alloys.

Increasing the Tensile Strength of Aluminum-Bronze and Muntz-Metal by Quenching. Erwin S. Sperry. Gives report of tests showing the effect of quenching. Ills. 1200 w. Brass Wld—Jan., 1909. No. 1839.

See also Bearing Metals and Manganese Bronze, under MATERIALS OF CONSTRUCTION.

Alloy Steels.

The Nature and Treatment of Alloy Steel. Dr. John A. Mathews. General information relating to the construction of alloy steels, the problems involved, and precautions necessary. 2500 w. Ir Age—Jan. 7, 1909. No. 1496.

The Nature and Characteristics of the New Steels. O. M. Becker. The present article deals with the physical constituents of steel and the nature of hardening. Ills. 5000 w. Engineering Magazine—Feb., 1909. No. 2160 B.

Bearing Metals.

The Problem of Bearing Metals. Samuel K. Patteson. A general review of the present bearing metal situation. 2000 w. Elec-Chem & Met Ind—Jan., 1909. No. 1680 C.

Anti-Friction Alloys for Bearings. A H. Hiorns. Read before the Birmingham Assn. of Mech Engrs. A study of the qualities required for an anti-friction alloy, and the essential points to be considered in a bearing metal. 4000 w. Mech Engr—Dec. 25, 1908. No. 1506 A.

Cast Iron.

Tests of Cast Iron (Versuche mit Gusseisen). C. Bach. Gives results of bending, tension and impact tests. Ills. Serial, 1st part. 4400 w. Zeitschr d Ver Deutscher Ing—Dec. 26, 1908. No. 2166 D.

Heat Insulation.

The Thermal Conductivity of Heat-Insulators. A review of the research work of Dr. Wilhelm Nusselt. 3300 w. Engng—Jan. 1, 1909. No. 1703 A.

See also same title, under MEASUREMENT.

Manganese Bronze.

Making Manganese Bronze. K. Kinn. Suggestions for making this alloy. 2000 w. Am Mach—Vol. 32. No. 4. No. 2139.

Metallography.

A New Polishing Machine for Metallographic Work. James Aston. Describes a machine devised in the Chem. Engng. Dept. of the Univ. of Wisconsin. 800 w. Elec-Chem & Met Ind—Jan., 1909. No. 1677 C.

See also Laboratories, under MEASUREMENT.

Refractory Materials.

See Blast-Furnace Lining, under MINING AND METALLURGY, IRON AND STEEL.

Steel.

The Modulus of Elasticity of High Tensile and Mild Steels. Describes recent experiments made by David Colville and Sons, Ltd., giving results. 1600 w. Mech Engr—Jan. 8, 1909. No. 1812 A.

The Hardness of Steel at Different Temperatures (La Dureté à Chaud des Aciers). M. Robin. Reports the results of careful tests on various steels at temperatures from 0 to 700 degrees C. Ills. 5000 w. Rev de Métal—Dec., 1908. No. 1909 E + F.

MEASUREMENT.

Calorimetry.

A New Bomb Calorimeter. Charles J. Emerson. Illustrated description of a new bomb of the Berthelot type. 1000 w. Jour Ind & Engng Chem—Jan., 1909. No. 2040 E.

See also Analysis, under MINING AND METALLURGY, COAL AND COKE.

Dynamometers.

Electric Dynamometers. G. Everett Quick. Illustrates and describes types. 1500 w. Power—Jan. 26, 1909. No. 2091.

Hardness.

The Comparative Method of Making Brinell Hardness Tests (Essai de Dureté Brinell par Méthode comparative). L. Grenet. A statement of its advantages, comparing its results with those of the ordinary method. 2000 w. Rev de Métal—Dec., 1908. No. 1912 E + F.

Heat Insulation.

The Testing of Heat Insulating Materials (Le Esperienze sui Materiali coibenti). Alfredo Bertella. Illustrated description of methods. 4800 w. Riv Marit—Dec., 1908. No. 1933 E + F.

Impact Tests.

The Definition of Resilience and Shock Tests (La Définition de la Résilience et les Essais au Choc). L. Révillon. Report of tests to determine the extent to which shock tests on bars of different sizes are comparable. Tables. 2500 w. Rev de Métal—Dec., 1908. 1908 E + F.

Laboratories.

A Modern Metallurgical Laboratory. A M. Portevin. Illustrated description of the apparatus used and methods employed in the chemical, mechanical and microscopical departments of the De Dion-Bouton works laboratory in France. 4500 w. Am Mach—Vol. 32. No. 3. No. 1864.

See also Education, under INDUSTRIAL ECONOMY.

Testing Machines.

A Mirror Apparatus for the Measurement of Elastic Deformations (Ueber einen Spiegelapparat zur Messung elastischer Längenänderungen). Bernhard Kirsch. Description of the device with discussion of its mathematics. Ills. 2500 w. Oest Wochenschr f d Oeffent Baudienst—Dec. 19, 1908. No. 1978 D.

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Torsion Tests.

Torsion Tests (Essais de Torsion). Pierre Breuil. Considers torsion tests as a means of selecting materials, and the relation between torsion and tensile tests. Results of investigations. Ills. 7000 w. Bul du Lab d'Essais—No. 14. No. 1902 N.

Water.

The Measurement of Large Quantities of Water (Jaugeages de gros Débits). MM. Boyer-Guillon, Auclair and Laedlein. Describes the calibration of weirs at the testing laboratories of the Conservatoire National des Arts et Métiers and tests on a centrifugal pump and on two hydraulic turbines. Ills. 20000 w. Bul du Lab d'Essais—No. 15. No. 1903 N.

POWER AND TRANSMISSION.

Air Compressors.

Rock Excavation with a Portable Compressor Outfit. Illustrates and describes the portable gasoline-engine compressor recently used for shallow trench work in New York City. 1600 w. Eng Rec—Jan. 2, 1909. No. 1427.

Belt Driving.

The Transmission of Power by Leather Belting. Carl G. Barth. Conclusions based principally on the experiments of Lewis and Bancroft. Gives diagrams and explanations of their use. Ills. 8000 w. Jour Am Soc of Mech Engrs—Jan., 1909. No. 1850 F.

Belt or Positive Chain Drive for Machine Tools (Riemenantrieb oder positiver Kettenantrieb für Werkzeugmaschinen). A. Bauschlicher. A comparison of the systems. Ills. Serial, 1st part. 2000 w. Zeitschr f Werkzeng—Dec. 15, 1908. No. 1982 D.

See also Pulleys, under POWER AND TRANSMISSION.

Chain Driving.

See Belt Driving, under POWER AND TRANSMISSION.

Compressed Air.

Researches on the Escape of Compressed Air from Small Tubes and the Eddy Currents Set Up (Untersuchungen über den Ausfluss komprimierter Luft aus Kapillaren und die dabie auftretenden Turbulenzerscheinungen). Dr. Ruckes. Reports researches similar to those of Osborne Reynolds on water. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—Dec. 26, 1908. No. 2107 D.

Electric Driving.

Speed Regulation of Machine Tools at the Fore River Shipyard. Illustrated article describing the interesting system for speed variations, the H. Ward Leonard multi-stage system of the Allis-Chalmers Co. 2500 w. Eng Rec—Jan. 2, 1909. No. 1425.

Electrically Driven Woodworking Machinery. James F. Hobart. A summary of shop power conditions and their treatment. 2500 w. Wood Craft—Jan., 1909. No. 1490.

Lubrication.

See same title, under AUTOMOBILES.

Mechanical Plants.

New Power Plant of Carnegie Institute. Thomas Wilson. Illustrated detailed description of a mechanical plant for an immense building. 7500 w. Power—Jan. 12, 1909. No. 1660.

Power Plants.

The Small Economics of a Power Plant. A. S. Atkinson. Urges the adoption of more scientific methods in a plant supplied with the ordinary reciprocating engines and their auxiliaries. 2200 w. Boiler-Maker—Jan., 1909. No. 1666.

See also Gas Power Plants, under COMBUSTION MOTORS; and Isolated Plants, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Pulleys.

The Crowning of Pulleys. J. Stormouth. The reason for crowning is explained and the usual practice discussed. 2000 w. Mech Wld—Jan. 15, 1909. No. 2056 A.

Pulley Data: Ratio of Diameters, Distance Between Centers and Arc of Contact. F. C. Helms. Gives curves for calculating the various dimensions, with explanation. 600 w. Elec Wld—Jan. 7, 1909. No. 1669.

Shafting.

The Alinement of New and Realinement of Old Shafting. James Lomas. An explanation of methods, illustrating devices. 1800 w. Am Mach—Vol. 32. No. 2. No. 1751.

STEAM ENGINEERING.

Boiler Draught.

Induced Draught in the Power House, and Modern Practice in Its Application. C. L. Browne. Presents the advantages of mechanical draught and discusses some points to be considered in connection with its installation. 2500 w. Elec Engr, Lond—Jan. 8, 1909. Serial, 1st part. No. 1804 A.

A Comparison of Natural and Induced Draught Systems. W. N. Y. King. Read before the Leeds Loc. Soc. of the Inst. of Elec. Engrs. A comparison of results based upon a particular case, under usual conditions. Ills. 5000 w. Elec Engr, Lond—Jan. 1, 1909. No. 1692 A.

See also Stacks, under STEAM ENGINEERING.

Boiler Fittings.

See Safety Valves, under STEAM ENGINEERING.

Boiler Furnaces.

Methods of Studying the Heat-Absorbing Properties of Steam Boilers. Loyd R. Stowe. Explains methods of study that

will give facts helpful in determining the arrangement of heating surface that will absorb the highest per cent. of heat. Discussion. 11800 w. Jour W Soc of Engrs —Dec., 1908. No. 1857 D.

Boiler Management.

See Hot Water Heating, under HEATING AND COOLING.

Boiler Rating.

A Standard Rating for Steam and Hot Water Heating Boilers. P. H. Seward. Contribution to committee on Rating House Heating Boilers. Thinks the capacity should be determined by tests made under standard conditions. 3000 w. Met Work—Jan. 23, 1909. No. 2013.

The Rating of House-Heating Boilers. William Kent. Suggests a method of testing small-sized boilers. 900 w. Heat & Vent Mag—Jan., 1909. No. 1886.

Boiler Repairs.

Driving Up Bags in Steam Boilers. M. Kennett. Explains the cause of bags and methods of repairing. 1000 w. Power—Jan. 19, 1909. No. 1834.

Boilers.

Notes on Water-Tube Boilers (Neuere Anschauungen über Wasserrohrkessel). Herman Garbe. A review of progress in this field. Ills. Serial, 1st part. 1600 w. Zeitschr f d Gesamte Turbinenwesen—Dec. 10, 1908. No. 1956 D.

Boiler Scale.

The Influence of Scale on Heat Transmission in Steam Boilers (De Invloed van Ketelsteen en andere Weerstanden op de Warmte-Transmissie bij Stoomketels). Chr. Muller. Reviews much of the literature of the subject. Ills. 5000 w. De Ingenieur—Dec. 5, 1908. No. 2116 D.

Boiler Waters.

Prevention of Scale-Formation in Steam Boilers by Electricity. F. A. Lart. Extract from an article in the *Engng. Rev.* A report of recently conducted experiments in the application of electricity to water purification. 2500 w. Ry & Engng Rev—Jan. 23, 1909. No. 2041.

The Chemical Aspect of Impurities in Steam Boilers. J. C. William Greth. Read before the Am. Inst. of Chem. Engrs. Describes the salts that enter into scale formation, the action of corrosive acids and salts, the requirements to properly soften and purify a water, etc. 6000 w. Ind Wld—Jan. 7 1909. No. 1477.

Condensers.

Saturated Air as a Cooling Agent. Arthur Pennell. Illustrates and describes the Pennell condensers. 1200 w. Power—Jan. 12, 1909. No. 1664.

Engine Design.

Present-Day Practice in High-Speed Engine Design. Considers points that govern the design and some of the details found successful. 1500 w. Mech Wld—Jan. 8, 1909. Serial. 1st part. No. 1815 A.

Engine Failures.

Some Recent Steam Engine Failures. Howard S. Knowlton. Illustrates and describes accidents reported by the engineering expert of a Casualty Co. 3000 w. Power—Jan. 12, 1909. No. 1663.

Engines.

Business Aspects of Early Engineering. H. W. Dickinson. Notes on the ways of conducting business in the early days of the introduction of the steam engine. 3000 w. Engr, Lond—Dec. 25, 1908. No. 1544 A.

Development of the High Speed Steam Engine. Abstract of lecture by Frank H. Ball before the Modern Science Club of Brooklyn, N. Y. Why the compound single valve engine is preferable where high efficiency is necessary. 2000 w. Power—Jan. 19, 1909. No. 1833.

Compound Horizontal Engine with Recke-Ruston Valve-Gear. Illustrated description of a large compound side-by-side engine designed to work with superheated steam. 700 w. Engng—Jan. 1, 1909. No. 1705 A.

Exhaust Steam.

See Turbine Plants, under STEAM ENGINEERING.

Feed-Water Heating.

Means and Methods for Heating the Feed-Water of Steam Boilers. Reginald Pelham Bolton. This third and last article of a series examines the economy of heating feed-water by exhaust steam. Ills. 1600 w. Engineering Magazine—Feb., 1909. No. 2158 B.

Relative Rate of Heat Transfer to Water At and Below the Boiling Point. W. M. Sawdon. Reports some tests made at Sibley College laboratory, giving results. 1500 w. Power—Jan. 12, 1909. No. 1661.

Fuels.

Some Fundamental Considerations on Coal. W. Jones. Considers the use of coal in raising steam and the importance of analysis, and of building the furnace to suit the coal to be used. 1300 w. Elec-Chem & Met Ind—Jan., 1909. No. 1676 C.

Coal; Its Composition and Combustion. William H. Booth. Discussion of the elements which combine to promote combustion. 3000 w. Power—Jan. 12, 1909. No. 1662.

See also Locomotive Fuels, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Fuel Testing.

See Analysis, under MINING AND METALLURGY, COAL AND COKE.

Indicator Diagrams.

Inaccuracies Due to Drum Motion Distortion. Julian C. Smallwood. Analysis of the cause of errors in indicator diagrams, with results of tests. 2500 w. Power—Jan. 26, 1909. No. 2089.

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Mechanical Stokers.

Mechanical Stokers (Mechanische Feuerungen). Karl Rubricius. A description and discussion of several German types. Ills. 2200 w. Elektrotech u Maschinenbau—Dec. 27, 1908. No. 1996 D.

Safety Valves.

A Cause of Rupture of Safety-Valve Seats (Sur une Cause de Rupture des Sièges de Soupapes). L. Lecornu. A discussion of faults due to improper casting. 1200 w. Rev de Mécan—Dec., 1908. No. 2102 E + F.

Stacks.

Furnace Draught in Central Heating Plants (Die Unterdruckverhältnisse im Innern einer Zentralheizungs-Kesselanlage). M. Hottinger. A theoretical discussion of chimney design and draught. Ills. 4000 w. Gesundheits-Ing—Dec. 5, 1908. No. 1964 D.

Steam Pipes.

The Strength of Oval Pipes under External or Internal Fluid Pressure (Festigkeit von ovalen Röhren gegen innern oder äusseren Flüssigkeitsdruck). M. Westphal. A mathematical demonstration of the method of calculation. Ills. 2000 w. Zeitschr d Ver Deutscher Ing—Dec. 26, 1908. No. 2109 D.

See also Water Hammer, under STEAM ENGINEERING.

Steam Properties.

Heat in Steam. Joseph H. Hart. An explanation of the connection between heat and steam and related matters. 2000 w. Power—Jan. 26, 1909. No. 2092.

Superheating.

Duscussion. Thermal Properties of Superheated Steam. Brief abstract of paper by R. C. H. Heck, with author's reply to discussion. 900 w. Jour Am Soc of Mech Engrs—Jan. 1909. No. 1852 F.

Turbine Design.

The Design of the de Laval Steam Turbine. A brief summary of the stages of design, giving the formulae involved. 2000 w. Prac Engr—Jan. 1, 1909. No. 1689 A.

The Design of Steam Turbines (Sul Calcolo delle Turbine a Vapore). G. B. Dall'Armi. A theoretical discussion with curves plotted from fundamental equations. Ills. 8000 w. Ann d Soc d Ing e d Arch Ital—Dec. 1, 1908. No. 1934 F.

Turbine Governors.

See Operation, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Turbine Plants.

A Notable Low Pressure Turbine Installation. Illustrated description of a Rattau regenerator and a 600 K. W. turbogenerator set at Vandergrift, Pa., supplying direct-current at 250 volts. 2500 w. Ir Age—Jan. 7, 1909. No. 1495.

Exhaust-Steam Turbine Plant at the Osterfeld Mine (Die Abdampfturbinenanlage der Zeche-Osterfeld). K. J. Müller. Illustrated description of the plant and its working and report of its economy. 3000 w. Glückauf—Dec. 5, 1908. No. 1951 D.

Turbines.

Melms-Pfenninger Steam Turbines. Trans. from *Die Turbine*. Ernest N. Jansen. Illustrated description. 1000 w. Jour Am Soc of Nav Engrs—Nov., 1908. No. 1891 H.

Valve Gears.

Setting the Valves of the Cummer Engine. H. E. Collins and J. H. Francis. An illustrated study of valve movement, with directions for overhauling and valve setting. 3000 w. Power—Jan. 26, 1909. No. 2087.

Valves.

The Use and Abuse of Globe Valves. W. H. Wakeman. Illustrates and describes the principal features of the different types. 2500 w. Power—Jan. 5, 1909. (Special No.) No. 1479 D.

Water Hammer.

Water Hammer. From the memorandum of the Chief Engineer to the Manchester Steam Users' Assn., explaining the danger and giving the solution of water hammer blows and the conditions that may cause explosions. 3000 w. Prac Engr—Jan. 15, 1909. Serial, 1st part. No. 2053 A.

TRANSPORTING AND CONVEYING.

Aerial Tramways.

Electrically Operated Aerial Tramways and their Applications (Die Elektrohängebahnen und ihre Verwendung). C. Claus. Illustrated description of various types and various applications. 2000 w. Elek Kraft u Bahnen—Dec. 14, 1908. No. 1991 D.

Cableways.

The Wetterhorn Cable Way (Der Wetterhornaufzug I Sektion). Illustrated description of the first section of a steeply inclined cable hoist on the slope of this mountain in Switzerland. Serial, 1st part. 2500 w. Schweiz Bau—Dec. 12, 1908. No. 1955 B.

Coal Handling.

Loading and Conveying Plants in German Gas Works. Illustrates and describes various plants. 3000 w. Sci Am Sup—Jan. 16, 1909. No. 1781.

Handling Coal by Electric Shovels. Edgar H. Wattington. Illustrates and describes the use of electric motors for crane driving. 1200 w. Ir Age—Jan. 14, 1909. No. 1747.

Coal Handling in Docks (Grundzüge für die Kohlenverladung beim Schiffsumschlag). Herr Berkenkamp. Illustrated vices. Serial, 1st part. 3500 w. Glückauf description of various methods and de—Dec. 12, 1908. No. 1953 D.

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Conveyors.

The Conveying of Materials. The Belt Conveyor. C. Kemble Baldwin. Abstract of paper with the author's reply to discussion. 3500 w. Jour Am Soc of Mech Engrs—Jan., 1909. No. 1853 F.

Cranes.

Design and Construction of Electric Overhead Cranes. R. B. Brown. A record of present practice in electrically-operated overhead cranes, with facts of value to designers. 2000 w. Mach, N Y—Jan., 1909. Serial, 1st part. No. 1549 C.

The Electric Traveling Crane. Walter G. Stephan. An illustrated discussion of the principles governing the design. 6500 w. Ir Trd Rev—Jan. 7, 1909. No. 1608.

Temperley Transporters. An illustrated article dealing with the various designs and the conditions they had to meet. 5000 w. Engng—Jan. 8, 1909. Serial, 1st part. Plate. No. 1819 A.

Elevators.

Design of a Short-run Plunger Elevator. C. R. Harris. Illustrated detailed description of the building and installing of such an elevator. 2000 w. Am Mach—Vol. 31. No. 53. No. 1401.

Design of a Balanced Plunger Elevator. C. R. Harris. Gives details for the design, building and installation of such an elevator. Ills. 1500 w. Am Mach—Vol. 32. No. 3. No. 1865.

Industrial Railways.

Miniature Railroads for Country Transportation. Illustrated description of the Blakesley Hall miniature railroad and other lines on English estates. 1200 w. Sci Am—Jan. 2, 1909. No. 1429.

Novel Industrial Railroad Installation. John M. Bruce. Illustrated description of the installation at the Cambridgeport plant of the Boston Woven Hose & Rubber Co. 1600 w. Ir Age—Jan. 14, 1909. No. 1748.

Ore Handling.

Ore-Handling Machinery at the N. Y. P. & O. Dock at Cleveland, Ohio. Harry E. Scott. Illustrated detailed description of the plant near the foot of W. 25th St., the electrical unloaders, their operation, speed, etc. 4000 w. Jour Worcester Poly Inst—Jan., 1909. No. 1841 C.

The Ore-Handling Plant of the Steel Works at Gary, Indiana. Illustrated detailed description of the equipment, as an example of the best American practice. 3000 w. Eng Rec—Jan. 2, 1909. No. 1419.

Recent Ore-Handling Plants at Iron Works (Einige neuere Beförderungsanlagen auf Hochofenwerken). Describes aerial tramway and cableway installations. 3500 w. Stahl u Eisen—Dec. 2, 1908. No. 1940 D.

See also Ore Bins, under MINING AND METALLURGY, MINING.

MISCELLANY.

Aeronautics.

The Conquest of the Air. J. F. Springer. An illustrated historical review of what has been accomplished. 4500 w. Ir Age—Jan. 7, 1909. No. 1500.

Mechanical Flight. Reviews the developments of the past year. Ills. 2200 w. Engr, Lond—Jan. 1, 1909. No. 1719 A.

The Theory of Air Propellers (Beitrag zur Theorie der Luftschrauben). Georg Wellner. Mathematical discussion of the theory and design of airship propellers. Ills. 4000 w. Zeitschr d Oest Ing u Arch Ver—Dec. 18, 1908. No. 1980 D.

Some Anchored Tests of Aerial Propellers. Walter A. Scoble. Gives results of some experiments made at the Blythewood Laboratory to determine the effect of varying the different elements and methods of construction. 1200 w. Engng—Dec. 25, 1908. No. 1535 A.

Some Considerations on the Flight of Birds (Quelques Considérations sur le Vol des Oiseaux). Wilhelm Kress. From L'Aéro-Mécanique. Ills. 5000 w. All Indus—Dec., 1908. No. 1924 D.

Birds and Aeroplanes (Oiseaux et Aeroplanes). Ch. Weyher. An argument to show that the most successful type of aeroplane will imitate as closely as possible the flight of birds. Ills. 4000 w. Rev Gen des Sci—Dec. 30, 1908. No. 1917 D.

Form and Stability of Aeroplanes. W. R. Turnbull. A report of researches on five types of aeroplanes. 4000 w. Sci Am Sup—Jan. 30, 1909. No. 2097.

Aeroplane Design and Construction. Discusses types, frames, systems of control, etc. Ills. 3500 w. Auto Jour—Jan. 2, 1909. No. 1686 A.

Difficulties in the Construction of Aeroplanes. Herbert Chatley. Describes some of the difficulties in applying the fundamental principles to the construction of actual machines. 5000 w. Jour Soc of Arts—Jan. 1, 1909. No. 1684 A.

Aeroplane Exhibition in Paris. A brief review, with remarks on the aeroplanes exhibited. 1000 w. Engr, Lond—Jan. 1, 1909. Serial, 1st part. No. 1717 A.

Aeroplanes and Motors at the First Paris Aeronautical Salon. Illustrates some of the exhibits, giving brief descriptions. 1800 w. Sci Am—Jan. 23, 1909. No. 2005.

The British Army Aeroplane. Brief illustrated description. 600 w. Sci Am—Jan. 30, 1909. No. 2096.

German and French Airships (Die deutschen und französischen Motorballons). Ansbert Vorreiter. Describes various airships and reviews progress in this field. Ills. Serial, 1st part. 3500 w. Zeitschr d Mit Motorwagen Ver—Dec. 15, 1908. No. 1972 D.

We supply copies of these articles. See page 1071.

Calculating Machines.

Mechanical Arithmetic and Time-Saving Devices. The first of a series of articles explaining devices for facilitating mathematical calculations. 800 w. Auto Jour—Jan. 16, 1909. Serial, 1st part. No. 2049 A.

Mathematics.

Mathematical Methods in the Investigation of Mechanical Problems (Mathematische Methoden zur Untersuchung mechanischer Probleme). Paul Stäckel. A discussion of the relation between mathematical theory and practical experiment. 4400 w. Zeitschr d Ver Deutscher Ing—Dec. 19, 1908. No. 2104 D.

Review of 1908.

Mechanical Engineering. Reviews improvements in marine engines, rolling stock, automatic couplers, internal combustion engines, etc. 5500 w. Engr, Lond—Jan. 1, 1909. No. 1718 A.

Textile Mills.

The Modern Cotton Spinning Factory. William H. Booth. An illustrated review of the present state of the cotton textile art. 8800 w. Cassier's Mag—Jan., 1909. Serial, 1st part. No. 1724 B.

Type-Setting Machines.

Type-casting and Composing Machinery. L. A. Legros. Deals with typographic surfaces which are produced directly by movable type or indirectly by means of movable matrices. Ills. 32500 w. Inst of Mech Engrs—Dec. 18, 1908. No. 1508 N.

MINING AND METALLURGY

COAL AND COKE.

Accidents.

The First Aid Movement in the Anthracite Region. H. H. Stoek. History and illustrated description of the methods and organizations. 5500 w. Mines & Min—Jan., 1909. No. 1417 C.

Analysis.

The Analysis of Coal and the Determination of the Calorific Value Therefrom. Arthur Caddick. Describes the method adopted by the author. 1000 w. Prac Engr—Jan. 15, 1909. No. 2052 A.

Bohemia.

The Eger Lignite Basin (Das Egerlander Braunkohlenbecken). Herr Bälz. Illustrated description of the coal deposits of this district in Bohemia. 7000 w. Glückauf—Dec. 26, 1908. No. 1954 D.

See also Mining, under COAL AND COKE.

Briquetting.

Coal Briquetting. R. M. Hale. Illustrated detailed description of the briquetting machine used by the Standard Fuel Co., Birmingham, Ala. 3500 w. Ir Age—Jan. 28, 1909. No. 2119.

China.

Coal Mining in China. Thomas T. Read. Information concerning the principal coal fields. Map. 2000 w. Min. & Sci Pr—Jan. 2, 1909. No. 1633.

Coking Plants.

See Washing, under COAL AND COKE.

Dust Extractors.

Appliances for Dealing With Coal Dust at the Pit Mouth. Illustrates and describes devices in use at different collieries for preventing the spread of coal dust or removing it. 3000 w. Ir & Coal Trds Rev—Jan. 8, 1909. No. 1829 A.

Electric Power.

Some Applications of Electric Power in Belgium (Quelques Applications de l'Electrotechnique en Belgique). Alfred Lambotte. This sixth and last article of the series on electric power in mining describes the electric installations of the Ressaix, Leval, Péronnes, Sainte-Aldegonde and Genck Collieries Company. Ills. Tables. 1500 w. Soc Belge d'Elecns—Dec., 1908. No. 1901 E.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

England.

The Geology of the Country between Newark and Nottingham. Information concerning these coal measures in England taken from a recent report of the Geol. Survey. 5000 w. Ir & Coal Trds Rev—Jan. 15, 1909. No. 2085 A.

Explosions.

Views Respecting Coal Mine Explosions. A symposium of opinions from engineers in reply to recent arguments advanced to explain causes of coal mine explosions. 6000 w. Eng & Min Jour—Jan. 2, 1909. No. 1439.

The Marianna Explosion. Plan and description of this mine in Western Pennsylvania and the accident, with reports of inspectors, etc. 8500 w. Mines & Min—Jan., 1909. No. 1414 C.

See also Mine Dust, under COAL AND COKE.

Explosives.

Tests of Safety Explosives (Versuche mit Sicherheitsprengstoffen). Herr Beyling. Report of tests of various explosives in an atmosphere of fire damp. 2500 w. Glückauf—Dec. 5, 1908. No. 1950 D.

Mine Dust.

The Present Position of the Coal Dust Problem. James and John Ashworth.

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Discusses various phases of this problem. 2500 w. Bul Can Min Inst—Jan., 1909. No. 2044 N.

Is Coal Dust, as Such, Explosive? Audley H. Stow. A study of the chemical reactions that occur in dust explosions. 4000 w. Eng & Min Jour—Jan. 2, 1909. No. 1440.

Spraying Coal Dust as a Colliery Safeguard. D. Harrington. Describes a sprinkling system, giving detailed costs of installation and operating as carried on in the mines of Utah. 3500 w. Eng & Min Jour—Jan. 23, 1909. No. 2030.

Dust Removal Devices in the Rhine Lignite District (Ueber Entstaubungsanlagen im rheinischen Braunkohlenindustriebezirk). Herr Baldus. Illustrated description of methods of removing dust from mine air. Serial. 1st part. 2600 w. Glückauf—Dec. 5, 1908. No. 1952 D.

Mine Ventilation.

The Principles of the Ventilation of Mines. A report of the second lecture of W. H. Hepplewhite, entitled, "Some Aspects of Mine Ventilation." 2500 w. Col Guard—Dec. 24, 1908. No. 1534 A.

Mining.

Lignite Coal Mining in Bohemia. William S. Hall. Describes methods employed in working thick pitching seams. Ills. 2800 w. Mines & Min—Jan., 1909. No. 1412 C.

Production.

Coal Mining in the United States in 1908. Reviews the mining conditions in important anthracite and bituminous centers. 11500 w. Eng & Min Jour—Jan. 9, 1909. No. 1583.

The Coal and Coke Trades of the United Kingdom in 1908. General and district reviews of the past year. 17500 w. Ir & Coal Trds Rev—Jan. 1, 1909. No. 1721 A.

Rescue Appliances.

Rescue Methods, with Special Reference to Underground Rescue Stations, and Recent Disasters (Das Grubenrettungswesen mit besonderer Berücksichtigung von unterirdischen Rettungsstationen und Beziehung auf die jüngsten Katastrophen). J. Mayer. Serial, 1st part. 5200 w. Oest Zeitschr f Berg u Hüttenwesen —Dec. 5, 1908. No. 1947 D.

Safety Lamps.

German Tests with Igniters for Safety Lamps. Bergassessor Beyling, in *Glückauf*. Reports results of experiments carried out at the experinemtal colliery, Gelsen-Kirchen. 1200 w. Col Guard—Dec. 24, 1908. No. 1533 A.

United States.

The Coalfields of the United States. Map and estimate tonnage, describing the character of the coals and annual production. 2000 w. Eng & Min Jour—Jan. 16, 1909. No. 1762.

The Coal Resources of the Southern States. Edward W. Parker. Reviews the development of the coal mining industry. 2500 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1561 C.

Washing.

Ernest Coal-Washing Plant. Illustrates and describes recent additions and improvements to this plant, located at Ernest, Pa. 1600 w. Mines & Min—Jan., 1909. No. 1411 C.

Surface Plant at the Crigglestone Colliery, near Wakefield. Describes the Lührig coal washers and the installation of Otto Hilgenstock Coke Ovens. Ills. 1200 w. Col Guard—Jan. 15, 1909. No. 2066 A.

COPPER.

British Columbia.

The Importance of Low Grade Boundary Ores in the Copper Production of Canada. A. B. W. Hodges. Information concerning these ores and their treatment. General discussion. 4500 w. Bul Can Min Inst—Jan., 1909. No. 2043 N.

Colorado.

Some Copper Deposits in the Sangre de Christo Range, Colorado. Rufus Mather Bagg, Jr. Describes the geology of this range and discusses the probable origin of the deposits. Ills. 3000 w. Ec-Geol—Dec., 1908. No. 1878 D.

Korea.

The Kosan Mine, Korea. A. D. Weigall. Brief account of this copper mine. 1200 w. Min & Sci Pr—Dec. 26, 1908. No. 1445.

Nevada.

Copper Mining at Ely, Nevada. Courtenay DeKalb. Gives the history of this important district, the geology, method of mining, etc. Ills. 2500 w. Min & Sci Pr —Jan. 2, 1909. No. 1635.

Ontario.

Canadian Copper Company. D. F. Browne. Plan and description of a new concrete building. 3500 w. Can Min Jour—Jan. 15, 1909. No. 1835.

Pennsylvania.

The Newark Copper Deposits of Southeastern Pennsylvania. Edgar T. Wherry. A study of these deposits, giving the history, geology and description. Map. 4000 w. Ec-Geol—Dec., 1908. No. 1877 D.

Pot Roasting.

The Pot Roasting of Copper Ores. S. Radcliff. An account of the development of the process in Australia, with a statement of the advantages. 3300 w. Aust Min Stand—Dec. 2, 1908. No. 1745 B.

Production.

The Copper Production of North America. Review of the production for 1908 in the United States, Mexico, and Canada. 6500 w. Eng & Min Jour—Jan. 9, 1909. No. 1580.

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Rolling Mills.

Electrically-Driven Brass and Copper Rolling Mills. C. A. Ablett. Abstract of paper read before the Birmingham Assn. of Mech. Engrs. An account of the methods of driving rolling mills for brass, copper and such metals. 3000 w. Mech Engr —Jan. 8, 1909. No. 1813 A.

Slag Car.

Slag Car Used at the Cananea Smelting Works. Charles F. Shelby. Illustrated description of cast steel bowl held upright by steel spring latches. 500 w. Eng & Min Jour—Jan. 23, 1909. No. 2033.

Smelter Fumes.

Copper Fumes Converted Into a Fertilizer Ingredient. Dr. John Sharshall Grasty. Explains how sulphuric acid is to be utilized in the manufacture of acid phosphate. 3000 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1568 C.

Smelter Stacks.

See Stacks, under CIVIL ENGINEERING, CONSTRUCTION.

Trade.

The Copper Situation. James Douglas. Discusses the factors controlling the copper mining industry. 1200 w. Min & Sci Pr—Jan. 2, 1909. No. 1625.

The year 1908 in the Copper Trade. H. M. Cole. A review of the remarkable rise and depression of this metal, the consumption, export, production, etc. 3000 w. Ir Age—Jan. 21, 1909. No. 1860.

Utah.

Smelting Conditions at Salt Lake. Courtenay De Kalb. Describes the conditions controlling the smelting industry in Utah. Also editorial. 4500 w. Min & Sci Pr—Jan. 2, 1909. No. 1628.

See also Copper, under ORE DRESSING AND CONCENTRATION.

GOLD AND SILVER.

Alaska.

Alaska and Yukon. T. A. Rickard. Maps and illustrated review of the mining centers, the discoveries of gold and the future possibilities. 3300 w. Min & Sci Pr—Jan. 2, 1909. Serial, 1st part. No. 1627.

Assaying.

The Mill Test for Gold versus the Assay—A Comparison in the Methods for Non-Technical Men. H. E. Haultain. Considers the assay much more reliable than the mill test. 2000 w. Can Min Jour —Jan. 1, 1909. No. 1460.

Colorado.

Cripple Creek in 1908. W. W. Travell. An account of the present condition of these gold mines. 2000 w. Min & Sci Pr—Jan. 2, 1909. No. 1632.

Cyaniding.

Progress in Cyanidation. Alfred James. A review of progress in different mining regions. Ills. 5000 w. Min & Sci Pr—Jan. 2, 1909. No. 1634.

B. & M. Circulating Tank. F. C. Brown. Illustrated description of an apparatus for the efficient treatment of ore by the cyanide process. 3000 w. Aust Min Stand—Dec. 9, 1908. No. 1895 B.

See also Electro-Cyaniding, under GOLD AND SILVER.

Dredging.

Developments in Gold Dredging During 1908. John Power Hutchins. Review of the year reporting great activity in California and progress in the Klondike. 4000 w. Eng & Min Jour—Jan. 23, 1908. No. 2032.

The Metallurgy of Gold Dredging. Explains some of the troubles and causes of failure, showing the necessity of improving the present practice. 4000 w. Min Jour—Jan. 9, 1909. No. 1817 A.

The Recovery of Values from River Bottoms. W. D. Egilbert. Describes the DuBois suction dredge of the latest type, and its operation. 2000 w. Min Wld—Jan. 16, 1909. No. 1783.

Electro-Cyaniding.

Operation of the Parks Electro-Cyanide Process. John R. Parks. Illustrated description, with a few practical results. 1800 w. Min Wld—Jan. 23, 1909. No. 2042.

Hydraulic Mining.

Alluvial Working at Addison's Flat, New Zealand. A. Gordon Macdonald. Illustrates and describes a system of hydraulic sluicing, the tailings being elevated by means of a "back balance." 1000 w. Eng & Min Jour—Jan. 23, 1909. No. 2031.

See also Ditches, under CIVIL ENGINEERING, WATER SUPPLY

Mexico.

Ore Deposits of the Velardena District, Mexico. J. E. Spurr and G. H. Garrey. A detailed description of the geology of the region, with a study of the silver-lead deposits. 12500 w. Ec-Geol—Dec., 1908. No. 1876 D.

Rio Plata Mine and Mill, Western Chihuahua. H. J. Baron. Illustrated description of this silver mine, the mining and ore treatment. 3300 w. Eng & Min Jour—Jan. 16, 1909. No. 1759.

Santa Eulalia Mines, Chihuahua. F. J. H. Merrill. Reviews the history of this group of silver mines which have been worked since 1703. Ills. 2500 w. Min & Sci Pr—Jan. 2, 1909. No. 1631.

Ontario.

The South Lorraine Silver District, Ontario. William B. Phillips. An account of the development of a district likely to become important. 1500 w. Eng & Min Jour—Jan. 23, 1909. No. 2037.

Production.

Gold, Silver and Platinum in 1908. A review of the influences and commercial conditions which governed the production

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and prices. 3000 w. Eng & Min Jour—Jan. 9, 1907. No. 1579.

Rhodesia.

See Gold Milling, under ORE DRESSING AND CONCENTRATION.

Tasmania.

The Magnet Silver Mining Company, N. L., Tasmania. E. A. de Lautour. Illustrated description of this property and its development. 1200 w. Aust Min Stand—Nov. 25, 1909. No. 1688 B.

Tierra del Fuego.

The Gold Regions of the Strait of Magellan and Tierra del Fuego. R. A. F. Penrose, Jr. A general account of the occurrence of gold in this little-known region. Ills. 3500 w. Jour of Geol—Nov.-Dec., 1908. No. 1731 D.

West Africa.

West Africa Goldfields at the Close of 1908. Examines the causes of the recent revival and discusses the future prospects of this field. 3500 w. Min Jour—Jan. 9, 1909. No. 1816 A.

Yukon.

See Alaska, under GOLD AND SILVER.

IRON AND STEEL.

Australia.

Iron Ores and Iron Production in Australia. J. Findlay. A review of the deposits in the different states and the extent of their development. 2500 w. Ir Trd Rev—Jan. 7, 1909. No. 1605.

Blast-Furnace Charges.

Blast Furnace Charge Calculator. Describes a circular rule, designed by R. Marshall, for enabling the smelter of copper to calculate the various quantities of fluxes for any given weight of charge. 800 w. Engr, Lond—Jan. 8, 1909. No. 1828 A.

Blast-Furnace Gas.

See Gas Power Plants, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Blast-Furnace Lining.

The Selection of Refractories. Considers the kind and quality of brick best suited for various parts of different furnaces. Ills. 8500 w. Ir Trd Rev—Jan. 7, 1909. No. 1609.

Blast-Furnace Practice.

See Electro-Metallurgy, under IRON AND STEEL.

Blast Furnaces.

Some American Blast Furnace Plants. The present article gives plan and description of the Haselton furnaces of the Republic Iron & Steel Co., and the plant of the Inland Steel Co., on the west shore of Lake Michigan. 2000 w. Engr, Lond—Jan. 8, 1909. Serial, 1st part. No. 1826 A.

British Columbia.

See Washington, under IRON AND STEEL.

Electro-Metallurgy.

Smelting of Iron Ore in the Electric Furnace, in Comparison with Blast Furnace Practice. Joh. Härdén. Compares the various classes of furnaces proposed for the purpose, with the blast furnace. 4000 w. Elec-Chem & Met Ind—Jan., 1909. No. 1678 C.

Experiments on Melting in the Induction Furnace. F. A. J. FitzGerald. An account of an experiment at the plant of the Am. Elec. Furnace Co., on the melting capacity of the induction furnace. 800 w. Elec-Chem & Met Ind—Jan., 1909. No. 1674 C.

The Largest Electric Steel Works. Joseph W. Richards. An account of the Girod works now building at Ugine, in Savoy, France. 1500 w. Elec-Chem & Met Ind—Jan., 1909. No. 1673 C.

The Girod Electrical Process for the Manufacture of Steel Castings. Illustrated description of an installation in Switzerland, with report of operative methods, cost, etc. 2500 w. Ir & Coal Trds Rev—Dec. 24, 1908. No. 1547 A.

See also same title, under ELECTRICAL ENGINEERING, ELECTRO-CHEMISTRY.

Ferro-Alloys.

The Dangers of Ferro-Silicon. Gives the report of D. R. Wilson, on "The Properties of Ferro-Silicon," showing the danger connected with its transport. 1500 w. Engng—Dec. 25, 1908. No. 1537 A.

Georgia.

Clinton or Red Ores of Georgia. Edwin G. Eckel. A review of a recent report by Dr. S. W. McCallie, concerning the distribution, character and origin of these ores. Ills. 2000 w. Ir Trd Rev—Jan. 7, 1909. No. 1603.

Germany.

The Sedimentary Brown Ore Deposits near Hollfeld in Bavaria (Die eluvialen Brauneisenerze der nördlichen Fränkischen Alb bei Hollfeld in Bayern). F. Klockmann. Describes the deposits and the ores. Ills. 4000 w. Stahl u Eisen—Dec. 30, 1908. No. 1944 D.

See also Trusts, under INDUSTRIAL ECONOMY.

Japan.

Steel Making in Japan. Theodore D. Morgan. Discusses the present standing and possibilities of the industry. 4000 w. Ir Age—Jan. 28, 1909. No. 2121.

Michigan.

The Swanzy Iron Ore District. An illustrated description of the operations of the Cleveland Cliffs Iron Co., and the laying out of the beautiful mining town of Gwynn. 1800 w. Ir Trd Rev—Jan. 7, 1909. No. 1602.

Minnesota.

Much Work Done During a Dull Year. Oliver J. Abell. An illustrated account of extensive stripping operations at Mesabi Range mines and the sinking of con-

crete shafts. 6500 w. Ir Trd Rev—Jan. 7, 1909. No. 1601.

Ohio.

The Mahoning Valley as an Iron Center. Joseph F. Froggett. Reviews the history of this iron district in Ohio, the present article covering the pioneer period. Ills. 3800 w. Ir Trd Rev—Jan. 21, 1909. Serial. 1st part. No. 1899.

Pig Casting.

The Gary Pig Casting Plant. Brief illustrated description of the Heyl & Patterson machines at Gary, Ind. 800 w. Ir Age—Jan. 14, 1909. No. 1746.

Piping.

Piping in Steel Ingots. J. F. Springer. An illustrated discussion of methods for its reduction and elimination. 5000 w. Cassier's Mag—Jan., 1909. No. 1729 B.

Rolling Mills.

Gas-Electric vs. Steam Equipment for Steel Mills. J. A. Knesche. A study of whether it would pay to discard good steam equipment and replace it with gas-electric equipment. 8500 w. Ir Trd Rev—Jan. 7, 1909. No. 1607.

The Bray Continuous Sheet Mill. Illustrated description of a mill at South Sharon, Pa. 1500 w. Ir Age—Dec. 31, 1908. No. 1397.

The Development and Present Condition of the Electric Power and Lighting Plants of the Peine Rolling Mills (Die Entwicklung und jetzige Berschaffenheit der elektrischen Kraftübertragungs- und Beleuchtungsanlagen der Akt.-Ges. Peiner Walzwerk). F. Hartig. Discusses the transformation and distribution of power in these large works. Ills. Serial. 1st part. 1900 w. Elek Kraft u Bahnen—Dec. 14, 1908. No. 1990 D.

Russia.

Russian Iron Trade Conditions. Gives the history of the proposed pool of the South Russian Iron Works. 2500 w. Ir Age—Jan. 21, 1909. No. 1861.

Steel Works.

The Works of the Indiana Steel Co. at Gary, Ind. This first of a series of illustrated articles describes the blast furnace equipment of a great plant under construction on the shore of Lake Michigan. 10000 w. Ir Trd Rev—Jan. 7, 1909. Serial. 1st part. No. 1606.

The Greatest Steel Plant in the World. First of a series of illustrated articles describing in detail the Gary Works of the Indiana Steel Co. 7000 w. Ir Age—Jan. 7, 1909. Serial. 1st part. No. 1491.

See also Electro-Metallurgy, under IRON AND STEEL; and Ore Handling, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Tennessee.

Iron Operations in the Chattanooga District. Edwin Higgins. An illustrated description of the general conditions and methods. 2500 w. Eng & Min Jour—Jan. 2, 1909. No. 1437.

Trade.

The Iron and Steel Industry in 1908. Reports a year of depression and small demand with gradual recovery. 8500 w. Eng & Min Jour—Jan. 9, 1909. No. 1582.

The Iron and Steel Trades in 1908. General and district reviews for the year. 15500 w. Ir & Coal Trds Rev—Jan. 1, 1909. No. 1722 A.

The Chicago, Philadelphia, Pittsburgh and Cincinnati Iron Trade in 1908. Reviews by T. J. Wright, A. A. Miller, Robert A. Walker, and H. Eugene Hall. 18000 w. Ir Age—Jan. 7, 1909. No. 1498.

The Tin Plate and Sheet Steel Trades in 1908. B. E. V. Luty. A review of the production and related statistics. 3300 w. Ir Age—Jan. 7, 1909. No. 1499.

United States.

The Delay in Southern Iron Development. Edwin C. Eckel. A review of the southern iron industry. 1800 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1563 C.

Washington.

Iron Ore Deposits of the Pacific Northwest. H. Cole Estep. A study of these deposits, particularly in Washington and British Columbia, their location, nature, extent and mining problems. Ills. 4000 w. Ir Trd Rev—Jan 7, 1909. No. 1604.

LEAD AND ZINC.

Lead Alloys.

See Alloys, under MISCELLANY.

Lead Assaying.

The Electrolytic Estimation of Lead and of Manganese by the Use of the Filtering Crucible. F. A. Gooch and F. B. Beyer. Demonstrates processes for the electrolytic deposition of lead dioxide and manganese dioxide. 1200 w. Am Jour of Sci—Jan., 1909. No. 1741 D.

Production.

The Production of Lead and Spelter in 1908. A review of mining conditions, production, prices, exports and imports during 1908. Also report of tin. 10000 w. Eng & Min Jour—Jan. 9, 1909. No. 1581.

Zinc Trade.

The London Spelter Market in 1908. A review by months. 1500 w. Eng & Min Jour—Jan. 23, 1909. No. 2035.

MINOR MINERALS.

Aluminium.

The Electrolytic Reduction of Aluminium as a Laboratory Experiment. M. deKay Thompson. Describes difficulties encountered in attempting to electrolyze a solution of aluminium oxide in melted cryolite according to the Hall patent, showing how they may be overcome to a certain extent. 1500 w. Elec-Chem & Met Ind—Jan., 1909. No. 1679 C.

Three new British Aluminium Works. Illustrated description of the Dolgarrog works in North Wales, the Wallsend works and the Kinlochleven works in western Scotland. 3500 w. Elec-Chem & Met. Ind—Jan., 1909. No. 1683 C.

Building Stone.

Building Stone of Oklahoma. L. L. Hutchison. Reports an unlimited supply of granite, sandstone, limestone and marble of good quality. 3500 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1566 C.

Granite and Marble Resources of the South. Ernest F. Burchard. Information concerning production, the distribution and quality of the deposits. 4000 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1564 C.

Cement.

A New Viewpoint of the American Portland Cement Industry. Edwin C. Eckel. Read before the Assn. of Am. Portland Cement Mfrs. Discusses the future growth of the industry, future prices, influence of patents, etc. 4500 w. Eng Rec—Jan. 9, 1909. No. 1571.

Cement Works at Southam. Illustrated detailed description. 2000 w. Engr, Lond—Jan. 1, 1909. Serial. 1st part. No. 1716 A.

Diamonds.

Diamond Mine in Pike County, Arkansas. John T. Fuller. Illustrated account of these diamond-bearing peridotites. 2500 w. Eng & Min Jour—Jan. 16, 1909. No. 1760.

Graphite.

Graphite in the South. Dr. F. W. Ihne. Information concerning the varieties of graphite, where found, the value of southern deposits, the development, etc. Ills. 10000 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1567 C.

Manganese.

See Lead Assaying, under LEAD AND ZINC.

Molybdenum.

Occurrence and Uses of Molybdenum Ores. Summary of facts in regard to the occurrence, production and uses, as given in a Bulletin of the Imperial Institute. 2500 w. Aust Min Stand—Dec. 9, 1908. No. 1894 B.

Natural Gas.

See Oil, under MINOR MINERALS.

Oil.

The Petroleum Resources of the United States. David T. Day. Considers the store of petroleum known within the limits of the country, the rate at which it is being exhausted, the extent of waste, and suggests methods by which its use may better serve both present and future needs. Map. 4000 w. Am Rev of Revs—Jan., 1909. No. 1735 C.

The Petroleum Industry of the United States. A review of developments in the various districts during the past year. 10000 w. Eng & Min Jour—Jan. 9, 1909. No. 1584.

Broad Survey of Southern Potentialities in Mineral Development. Dr. David T. Day. Information concerning the development of oil-fields, sulphur beds, natural gas, and the chemical industries. 6000 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1555 C.

Oil and Gas in Oklahoma. Charles N. Gould. Reviews the discoveries thus far made and their development. 2000 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1562 C.

S. Pearson & Son's Uncontrollable Oil Gusher. Illustrated account of the well near Dos Bocas, Mexico, which burned nearly two months and defeated all efforts to save the oil. 2000 w. Eng & Min Jour—Jan. 2, 1909. No. 1438.

See also Natural Resources, under INDUSTRIAL ECONOMY.

Phosphate.

Tennessee's Big Phosphate Field. W. D. Hastings. An account of the discovery and development. Ills. 2500 w. Mfrs' Rec—Jan. 7, 1909. (Special No.) No. 1569 C.

Platinum.

See Production under GOLD AND SILVER.

Production.

Production of Other Metals and Minerals. Report for the past year concerning the production of aluminum barytes, borax, phosphate rock, quicksilver, cyanamide, etc. 6500 w. Eng & Min Jour—Jan. 9, 1909. No. 1587.

Salt.

The Stassfurt Salt Mines in Harz Mts., Germany. Albert B. Green. Brief illustrated description. 2000 w. Min Wld—Jan. 16, 1909. No. 1782.

The Schernthanner Method of Opening Up Salt Mines by Means of Boreholes (Die Schernthannersche Werks-Veröffnung mit Bohrlochwässerung). Hans Vogl. Illustrated description of method of opening up rock-salt workings by leaching methods. 2700 w. Oest Zeitschr f Berg- u Hüttenwesen—Dec. 19, 1908. No. 1949 D.

Sulphur.

See Oil, under MINOR MINERALS.

Tin.

The Origin of the Tin Ores of the Rooiberg District, Transvaal. Information from a recent paper by Mr. Recknagel, published in the Trans. of the Geol. Soc. of S. Africa. 1200 w. Min Jour—Dec. 19, 1908. No. 1530 A.

Mining in the Malay States. E. Seaborn Marks. An illustrated account of this mining region which produces over 60% of the world's tin supply. 4000 w. Min & Sci Pr—Jan. 2, 1909. No. 1630.

The London Tin Market in 1908. A review by months. 3000 w. Eng & Min Jour—Jan 23, 1909. No. 2034.

We supply copies of these articles. See page 1071.

Tungsten.

Tungsten Deposits and Surface Enrichment. Gordon Surr. Describes tungsten deposits, and discusses the possibility of secondary enrichment. 3000 w. Min Wld—Jan. 2, 1909. No. 1444.

MINING.

Blasting.

The Gases Resulting from the Use of High Explosives. William Cullen. The effect of explosives on the atmosphere of mines, giving results of experiments and points bearing on mine ventilation. 7800 w. Jour Chem, Met & Min Soc of S Africa—Nov., 1908. No. 1801 E.

Diamond Drilling.

Important Features of Diamond Core Drilling. C. J. McCord. Presents unusual features of the work. Ills. 4500 w. Min Wld—Jan. 2, 1909. Serial. 1st part. No. 1442.

Electric Hoisting.

Electrical Winding in South Wales. Illustrated description of the installation at the Maritime pit of the Great Western Colliery Co. 2000 w. Elec Rev, Lond—Jan. 1, 1909. No 1693 A.

Losses in the Ilgner Hoisting System and Determination of the Most Economical Slip of Its Starting Motors (Verluste bei Ilgner-Förderanlagen und Bestimmung der wirtschaftlichsten Schlüpfung ihrer Anlassmotoren). L. Becker. Mathematical and theoretical. Ills. 2000 w. Elektrotech Zeitschr—Dec. 24, 1908. No. 2115 D.

Electric Power.

See Accumulators, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Explosives.

Twenty Years' Progress in Explosives. Oscar Guttmann. A review of progress giving information concerning their manufacture, composition, etc. 5500 w. Jour Soc of Arts—Dec. 25, 1908. Serial. 1st part. No. 1503 A.

See also same title, under RAILWAY ENGINEERING, TRAFFIC.

Haulage.

The Mosgrove Incline. William L. Affelder. Describes the method of construction used to avoid common defects. Of interest to coal operators. 1200 w. Mines & Min—Jan., 1909. No. 1415 C.

New Hauling Station, Great Boulder Mine, W. A. Illustrated description of a new station at Kalgoorlie, W. A. 1800 w. Aust Min Stand—Dec. 9, 1908. No. 1893 B.

Electrically Operated Slag Railway of the Alpine Mining Company, Donawitz, Austria (Elektrisch betriebner Haldenaufzug der österreichischen Alpinen Montangesellschaft in Donawitz). Illustrated description of this electrically operated rope-haulage plant. 1500 w. Oest Zeitschr f Berg-u Hüttenwesen—Dec. 12, 1908. No. 1948 D.

Hoisting.

Dynamics of Colliery Winding Ropes, Cages, Guide Ropes, and Tubs. A. Hanley. Read before the Nat. Assn. of Col. Mgrs. Illustrated discussion of methods of testing and description of the author's inventions. 2500 w. Ir & Coal Trds Rev—Jan. 15, 1909. No. 2086 A.

Hoisting Engines.

Automatic Throttle-Closing Device for Hoisting Machinery. Spencer S. Rumsey. Describes an invention in use at the mines of the Oliver Iron Mining Co. 1500 w. Mines & Min—Jan., 1909. No. 1416 C.

Mine-Lamps.

Acetylene Mine-Lamps. A. Cressy Morrison. Information concerning their use and cost. 1000 w. Min & Sci Pr—Jan. 23, 1909. No. 2129.

Ore Bins.

Construction and Method of Operation of Ore Bunkers at Skagway. A. L. Bardoe. Brief illustrated description. 600 w. Bul Can Min Inst—Jan., 1909. No. 2045 N.

Ore Handling.

See same title, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Quarries.

The Pen Lee Stone Quarries. Illustrated description. 1500 w. Quarry—Jan., 1909. No. 1723 A.

Tunneling.

See Tunneling Machines, under CIVIL ENGINEERING, CONSTRUCTION.

Wire Ropes.

Cross-Laid Double-Layer Wire Ropes. An account of experiments recently made with such ropes, and some serious objections to their use. 800 w. Engr, Lond—Jan. 15, 1909. No. 2082 A.

ORE DRESSING AND CONCENTRATION.

Classification.

Classification at El Tiro Mill, Pima County, Arizona. George W. Brown. Gives a report of working results with the Richards pulsator classifier. 1200 w. Mines & Min—Jan., 1909. No. 1410 C.

Classification of Ores at the Butte Reduction Works. A. H. Wethey. Describes the use of the Pratt centrifugal screen for sizing without regard to specific gravity. 1500 w. Mines & Min—Jan., 1909. No. 1413 C.

Classifiers.

The Richards Pulsator Jig and Pulsator Classifier. Frank E. Shepard. Read before the Colo. Sci. Soc. Illustrated detailed description. 2200 w. Min Wld—Jan. 9, 1909. No. 1652.

Copper.

The Boston Consolidated Mill at Garfield, Utah. Leroy A. Palmer. Illustrates and describes the large mill built

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to treat sulphides with gold and silver values amounting to only 20 cts. per ton. The property can produce 50,000,000 lb. of copper annually with the estimated tonnage and values. 3500 w. Min Wld—Jan. 12, 1909. No. 1443.

Gold Milling.

Description of Ore Treatment at the Giant Mine, Hartley District, Rhodesia. Reginald C. H. Cooke. Describes the process of extraction used for a heavily mineralized chloride schist, intermixed with ironstone and quartz. 2500 w. Jour Chem, Met, & Min Soc of S Africa—Nov., 1908. No. 1802 E.

Grinding.

The Computation of Crushing Efficiency of Fine Grinding Machines. H. Stadler. A study, giving tables and calculations, and emphasizing the importance of care in making grading analyses. 3000 w. Jour S African Assn of Engrs—Dec., 1908. No. 2047 F.

Jigs.

See Classifiers, under ORE DRESSING AND CONCENTRATION.

Lead Milling.

Milling Costs. R. S. Handy. Suggestions for arriving at milling costs and efficiency, with daily report blank. 1000 w. Min & Soc Pr—Jan. 23, 1909. No. 2130.

Mill Tests.

See Assaying, under GOLD AND SILVER.

Sampling.

Methods of Sampling Iron Ore. J. M. Camp. Explains the systems of commercial sampling adopted by the U. S. Steel Corporation. 2200 w. Ir Trd Rev—Jan. 28, 1909. No. 2131.

Silver Milling.

See Mexico, under GOLD AND SILVER.

MISCELLANY.

Alloys.

The Alloys of Lead (Les Alliages de Plomb). A. Portevin. Summarizes the results of Prof. Tammann's researches on alloys of lead with calcium, cobalt, chromium, indium, potassium, sodium, palladium, platinum, antimony, thallium, etc. Ills. 3500 w. Rev de Métal—Dec., 1908. No. 1911 E + F.

Ore Deposits.

See Tin, and Tungsten, under MINOR MINERALS.

Review of 1908.

Mining and Metallurgy in 1908. Editorial review. 7000 w. Min Jour—Dec., 26, 1908. No. 1532 A.

Mining in the United States During 1908. Reviews progress at the various camps. Maps. 2400 w. Eng & Min Jour—Jan. 9, 1909. No. 1585.

Mineral and Metal Production in 1908 A summary of the production of the more important minerals and metals in the United States. 700 w. Eng & Min Jour—Jan. 9, 1909. No. 1578.

Review of Mining in Foreign Countries. Reviews the developments of the past year in the Transvaal, Peru, Chile, Colombia, Mexico, Ontario and Australia. 17000 w. Eng & Min Jour—Jan. 9, 1909. No. 1586.

The Mining Market in 1908. Briefly reviews the general characteristics of the year and the course of the market. 3000 w. Min Jour—Jan. 2, 1909. Serial. 1st part. No. 1702 A.

U. S. Geological Survey.

Work of the United States Geological Survey in 1908. 2500 w. Eng & Min Jour—Jan. 23, 1909. No. 2036.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

The Safety of British Railways. Reviews the accident records for various years and Acts passed that have a bearing on the safety of railways. 1600 w. Engr, Lond—Jan. 8, 1909. No. 1825 A.

Dispatching.

Telephone Train Dispatching. Discusses the elements that make up an operative system. 2500 w. Sig Engr—Jan., 1909. No. 1837.

Signaling.

Block Signal and Control Board: First Annual Report to the Interstate Commerce Commission. The report of a board appointed to investigate the use and necessity for block signal systems and automatic control appliances on railways is given nearly in full. 8000 w. Eng News—Jan. 14, 1909. No. 1786.

Interlocking Facilities of the St. Louis Terminal Railroad Assn. of St. Louis. A. D. Cloud. An illustrated account of extensive improvements made to handle the traffic in connection with the World's Fair of 1904. 8000 w. Sig Engr—Jan., 1909. No. 1836.

Trains.

The Southern Belle Express. Illustrated description of a fine train recently put in service on the L., B. & S. C. Ry. of England. 1000 w. Engr, Lond—Jan. 8, 1909. No. 1824 A.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

High Brake Cylinder Pressures. G. W. Kiehm. Explains the action of air brakes and discusses the arguments for and against the employment of higher pressures. 1500 w. Ry & Loc Engng—Jan., 1909. No. 1447 C.

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Car Heating.

Vapor Car Heating System. Illustrated description of the system invented by Edward E. Gold. 2200 w. Ry & Loc Engng—Jan., 1909. No. 1450 C.

Car Trucks.

Cast Steel Frames of the Arch-Bar Type for Car Trucks. Illustrated description of an arch-bar frame with the journal boxes cast as a part of the frame. 900 w. Eng News—Jan. 7, 1909. No. 1640.

Couplers.

Polar Coupler on the Pennsylvania. Illustrated description of new coupler designed for new steel cars. 800 w. Ry & Loc Engng—Jan., 1909. No. 1451 C.

Draft Gear.

Southern Pacific Draft Gear Tests. A report of tests made on the Los Angeles division of the So. Pacific to show the advantage of the Westinghouse friction draft gear in freight service. 1800 w. R R Age Gaz—Jan. 8, 1909. No. 1650.

Electrification.

New York Central Railway Electrification. Brief illustrated description of the conversion of a part of this steam railway to electric traction on the continuous current system. 3000 w. Tram & Ry Wld—Jan. 7, 1909. No. 2057 B.

Freight Cars.

Summers Ore Car for the Duluth & Iron Range. Illustrated description of a self-clearing car. 600 w. R R Age Gaz—Jan. 29, 1909. No. 2145.

Fruit and Vegetable Cars for the San Antonio & Aransas Pass. Illustrated description of cars containing new features in the ventilating arrangements. 400 w. R R Age Gaz—Jan. 29, 1909. No. 2144.

Lifting Jacks.

Mechanical Lifting of Railway Rolling Stock (Note sur le Levage mécanique des Véhicules de Chemins de Fer et notamment des Voitures à Bogies). M. Oudet. Describes compressed air, hydraulic, and electric apparatus for lifting cars from their trucks. Ills. Plates. 3300 w. Rev Gen des Chemins de Fer—Dec., 1908. No. 1914 G.

Locomotive Boilers.

Regulating Valves for Locomotive Boilers. Describes an improved design recently patented in England. Ills. 700 w. Mech Engr—Jan. 1, 1909. No. 1510 A.

Locomotive Cleaning.

Scouring Plant in the Saarbrücken Shops (Auskochanlage in der Hauptwerkstätte Saarbrücken). Herr Halfmann. Illustrated description of a successful plant for cleaning locomotive parts by steam, with costs 2500 w. Glasers Ann—Dec. 15, 1908. No. 1971 D.

Locomotive Crank Axles.

Tests of Frémont-Type Crank Axles (Essais d' Essieux condés à Flasques évidées). E. Hallard. The results of tests on the Chemin de Fer du Midi show that the form of crank devised by M. Frémont is an improvement over that commonly used. Ills. 1500 w. Rev Gen des Chemins de Fer—Dec., 1908. No. 1913 G.

Locomotive Design.

Design of Oil Burning Locomotives. Harrington Emerson. Presents a comparison between the limitations of coal burning and oil burning locomotives, and the effect on design. 1000 w. Am Engr & R R Jour—Jan., 1909. No. 1592 C.

Locomotive Fireboxes.

The Life of Side Sheets of Wide Fireboxes. C. A. Seley. Discusses their design. General discussion. Ills. 13000 w. Pro W Ry Club—Dec. 15, 1908. No. 1797 C.

A New Departure in Flexible Stay-Bolts. H. V. Wille. Proposes the use of high carbon spring steel and to increase the unit tensile stress. Ills. 1200 w. Jour Am Soc of Mech Engrs—Jan., 1909. No. 1851 F.

Locomotive Flues.

Endurance of Flue Material in Locomotives. Alexander Kearney. Read before the Richmond R. R. Club. Considers the method of application, the composition and the changes which affect its endurance under service conditions. 1700 w. Boiler Maker—Jan., 1909. No. 1665.

Locomotive Fuels.

Petroleum Residues as Fuel on the Roumanian Railways. Information concerning this fuel and the method of burning it. 2000 w. Engr, Lond—Dec. 25, 1908. No. 1542 A.

Installations and Apparatus used on Roumanian Railways for Firing Locomotive Boilers with Petroleum Residues (Description des Installations et des Appareils en Usage aux Chemins de Fer de l'Etat Roumain pour l'Emploi des Résidus de Pétrole au Chauffage des Locomotives). Th. Dragen. Detailed description. Ills. 8500 w. Rev Gen des Chemins de Fer—Dec., 1908. No. 1915 G.

Locomotive Performance.

The Work of Superheater and Compound Locomotives. Charles R. King. Gives charts showing the power capacity of such engines for comparison, with a study of the results shown. 3500 w. Engr, Lond—Dec. 25, 1908. No. 1540 A.

Locomotives.

Standard Atlantic and Mogul Locomotives for the Harriman Lines. Illustrated descriptions, with explanatory remarks. 1500 w. R R Age Gaz—Jan. 1, 1909. No. 1463.

Locomotives of the Pacific Type of the French Western Railway. Robert Dubois. Gives the proposed specification and an illustrated description of the engines. 2000 w. Bul. Int Ry Cong—Dec., 1908. No. 2006 G.

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Compound Goods Locomotive, 0-10-0 Type, Servian State Railways. Illustration, with brief description. 500 w. Mech Engr—Jan. 1, 1909. No. 1509 A.

Twelve-Wheeled Duplex Tank Locomotive; Nitrate Railways Co., Chili. Illustrates and describes tank-engines of unusual size, weight, and power. 1500 w. Engng—Jan. 1, 1909. No. 1708 A.

Schmidt Superheater Locomotives Outside of Germany (Die Heissdampflokomotive, Bauart Schmidt, im Auslande). C. Guillery. Reviews their use in other European countries. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—Dec. 5, 1908. No. 1999 D.

Mallet Compound Locomotive of the Hedjaz Railway (Locomotive compound Mallet du Chemin de Fer de l'Hedjaz, Arabia). Illustrated description with detailed drawing. 1000 w. Génie Civil—Dec. 5, 1908. No. 1927 D.

Locomotive Valve Gears.

Baker-Pilliod Locomotive Valve Gear. Illustrates and describes this new gear and its application. 700 w. Am Engr & R R Jour—Jan., 1908. No. 1595 C.

Locomotive Wheels.

Flange Lubrication on Southern Pacific System. Illustrated description of the flange lubricator with report of the results of its use. 700 w. R R Age Gaz—Jan. 15, 1909. No. 1792.

Motor Cars.

The McKeen Motor Cars. Illustrated description of a combination passenger and baggage car driven by gasolene. 1000 w. R R Age Gaz—Jan. 14, 1909. No. 1791.

Accumulator Motor Cars of the Prussian State Railways (Automotrices à Accumulateurs des Chemins de Fer de l'Etat prussien). Illustrated detailed description. Plate. 2900 w. Génie Civil—Dec. 26, 1908. No. 1931 D.

Traction by Petrol-Electric Motor Cars on the Arad-Csanad Railways, Hungary (La Traction par Automotrices pétrolés-électriques sur les Chemins de Fer d'Arad-Csanad, Hongrie). Illustrated description of the mechanical details of the cars and a discussion of the economic results. 3000 w. L'Elecn—Dec. 19, 1908. No. 1922 D.

Passenger Cars.

All-Steel Suburban Cars. Brief illustrated description of cars for the Long Island R. R. 500 w. Am Engr & R R Jour—Jan., 1909. No. 1594 C.

Shops.

The New Car Shops of the Union Pacific at Omaha. Illustrated detailed description. 1500 w. R R Age Gaz—Jan. 29, 1909. No. 2147.

Battle Creek Shops of the Grand Trunk Ry. Illustrated description of shops recently opened for service. 3000 w. Ry & Engng Rev—Jan. 16, 1909. No. 1831.

The Works of the Chicago, New York & Boston Refrigerator Company. A reconstructed plant in Chicago, for the construction and repair of freight cars is illustrated and described. 2500 w. Eng Rec—Jan. 23, 1909. No. 2028.

See also Yards, under PERMANENT WAY AND BUILDINGS.

Trucks.

See Wheel Base, under MOTIVE POWER AND EQUIPMENT.

Wheel Base.

The Wheel Base of Railway Rolling Stock. Roger Atkinson. A study of the action of different arrangements of wheel base and trucks. Ills. 3000 w. Ry & Loc Engng—Jan, 1909. No. 1449 C.

NEW PROJECTS.

Mexico.

The Mexican Central Railway's Pacific Extension. Detailed description with plan of the extension and the Manzanillo terminal. 3500 w. Eng Rec—Jan. 9, 1909. No. 1576.

Southern Pacific.

The Southern Pacific Lines in Mexico. Map and illustrated account of the construction of a main trunk line and branches on the west coast. 3000 w. R R Age Gaz—Jan. 1, 1909. No. 1461.

Virginia.

The Carolina, Clinchfield & Ohio Ry. Illustrated detailed description of the physical characteristics of a new line, to develop a new coal district of Virginia. 6000 w. Eng News—Jan. 21, 1909. No. 1872.

PERMANENT WAY AND BUILDINGS.

Crossings.

Building and Maintaining Railroad Crossings. W. C Sparks. Read before the Cent. Elec. Ry. Assn. Discusses points that should be considered in their construction and economical maintenance. 1500 w. Engng-Con—Dec. 30, 1908. No. 1454.

Cut Slopes.

The Use of Locomotive Ashes for Maintaining the Slopes of Cuttings. W. Bauer. Describes the method of application so as to protect the slopes against wet and frost. 1800 w. Bul Int Ry Cong—Dec., 1908. No. 2007 G.

Grade Reduction.

Reconstruction of a Portion of the Canadian Pacific Railway. An illustrated account of improvement in grades in the Kicking Horse Valley. 2000 w. Engr, Lond—Dec. 25, 1908. No. 1541 A.

Rail Records.

Pennsylvania Rail Record-Blanks. Gives blanks used for keeping a record of rail failures, with related information. 1000 w. R R Age Gaz—Jan. 1, 1909. No. 1462.

Reconstruction.

Revision of Line of the Kanawha &

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Michigan Ry.; With Unit Costs of the Work. J. A. Stocker. Describes revisions of line and grade in Ohio, eliminating many objectionable curves. Ills. 2000 w. Eng News—Jan. 7, 1909. No. 1637.

See also Grade Reduction, under PERMANENT WAY AND BUILDINGS.

Roundhouses.

East Buffalo Roundhouse. Illustrated description of a new 30 stall roundhouse for passenger locomotives of the N. Y. C. & H. R. R. R. 3000 w. Am Engr & R R Jour—Jan, 1909. No. 1593 C.

Stations.

See Steel, under CIVIL ENGINEERING, CONSTRUCTION.

Tunnel Ventilation.

A Study of Tunnel Ventilation (Studi delle Ferrovie dello Stato sulla Ventilazione delle Galerie). An illustrated account of a study made by the Italian state railways. Serial. 1st part. 4000 w. Ing Ferro—Dec. 1, 1908. No. 1938 D.

Yards.

Gary Classification Yard of the Chicago, Lake Shore & Eastern. Gives plan and brief description of the 15000 car classification yard at Gary, Ind., and the new shop plant. 700 w. R R Age Gaz—Jan. 8, 1909. No. 1649.

TRAFFIC.

Explosives.

Safe Handling and Transportation of Explosives and Inflammables. Col. B. W. Dunn. Gives an idea of the extent of this Business Administration. 2200 w. R R of regulations wisely enforced.. Ills. 10500 w. Pro Ry Club of Pittsburgh—Dec., 1008. No. 2098 C.

The American Railway Association's Bureau for the Safe Transportation of Explosives and Other Dangerous Articles. Col. B. W. Dunn. A sketch of the origin of this Bureau, the general nature of the work, and its possible lines of development. 5500 w. Pro N Y R R Club—Feb. 19, 1909. No. 2099.

MISCELLANY.

Associations.

Work of the American Railway Association. W. F. Allen. From an address on "Railway Operating Associations," delivered before the Harvard School of business, accounts of accidents, and need Age Gaz—Jan. 22. 1909. Serial. 1st part. No. 2002.

India.

A Railway to India. C. E. D. Black. Map and discussion of a projected line through Northern Arabia and Southern Persia, connecting Egypt and India. 3000 w. Nineteenth Cent—Jan., 1909. No. 1838 D.

New Zealand.

New Zealand Government Railways. A review of the report for the year ending March 31, 1908. 2500 w. Engng—Jan. 8, 1909. No. 1820 A.

Review of 1908.

Railways and Tramways. A summary of railway work in different parts of the world. 6000 w. Engr, Lond—Jan. 1, 1909. No. 1720 A.

South Africa.

The Working of the Railways in the South African War. W. Hyde Kelly. On the organization and work of a military railway staff. 4000 w. Engng—Jan. 15, 1909. No. 2079 A.

United States.

Twenty-Second Annual Report of Interstate Commerce Commission. Extracts from the report transmitted to Congress Jan. 11. 3500 w. R R Age Gaz—Jan. 15, 1909. No. 1790.

STREET AND ELECTRIC RAILWAYS

Adhesion System.

See Switzerland, under STREET AND ELECTRIC RAILWAYS.

Cars.

The Life and Wear of Rolling-Stock. M. Stahl. A report dealing with answers to questions sent out in regard to improvements in axles, wheels and tires, with a study of new types of cars. Ills. 3000 w. Elect'n, Lond—Jan. 15, 1909. Serial. 1st part. No. 2072 A.

Suggested Improvements in the Construction of Our Electric Tramways. Gerald H. J. Hooghwinkel. Presents the advantages of the single-track, single-deck car urging its adoption in England. 1500 w. Tram & Ry Wld—Jan. 7, 1909. No. 2059 B.

Combination Closed and Open Car of Pay-As-You-Enter Type for the Third Avenue Railroad Company, New York. Illustrated description of the design of new cars ordered. 3000 w. Elec Ry Jour—Jan. 23, 1909. No. 1898.

See also Track, under STREET AND ELECTRIC RAILWAYS.

Car Testing.

An Autographic Recording Apparatus for Electric Railway Tests. Albert T. Childs. Illustrated description of an autographic testing apparatus which records in curves the continuous electrical performance of a car. 1800 w. Jour Worcester Poly Inst—Jan., 1909. No. 1840 C.

Conductors.

Three-Wire System for Tramways. E. Goulding. Presents the advantages and

economics of this system. Ills. 1500 w. Tram & Ry Wld—Jan. 7, 1909. No. 2058 B.

Interurban.

New Interurban Railways in the Central States. Map and general information. 2000 w. Elec Ry Jour—Jan. 2, 1909. No. 1435.

Pittsburg, Harmony, Butler & New Castle 1200-Volt D. C. Railway. John R. Hewett. Illustrated detailed description of the electrification scheme. 2200 w. Elec Ry Jour—Jan. 16, 1909. No. 1754.

Locomotives.

Electric Locomotives for the Great Northern. Illustrates and describes the mechanical construction which is a distinct departure from previous practice. 600 w. R R Age Gaz—Jan. 15, 1909. No. 1793.

Rack Railways.

See Switzerland, under STREET AND ELECTRIC RAILWAYS.

Records.

A System of Record Keeping as Applied to Electric Railway and Tramway Equipment. R. J. M. Holmes. Outlines a card filing system of record keeping. 1000 w. Elec Rev, Lond—Jan. 15, 1909. No. 2063 A.

Substations.

See same title, under ELECTRICAL ENGINEERING, TRANSMISSION.

Subways.

Engineering Features of the Washington Street Tunnel. Illustrated description of this Boston tunnel and its relation to the rapid transit facilities. 3500 w. Engng—Jan. 15, 1909. No. 2074 A.

Arnold Report on New York Subway Traffic. The sixth report by Bion J. Arnold, dated Dec. 31, 1908. 4000 w. Elec Ry Jour—Jan. 30, 1909. No. 2133.

See also Reinforced Concrete, under CIVIL ENGINEERING, CONSTRUCTION.

Surface Contact.

The "G. B." System from a Tramway Manager's Point of View. Stanley Clegg. Read before the Inst of Elec. Engrs. Describes the system as installed at Lincoln, giving the writer's experience of it under working conditions. 7500 w. Elec Engr, Lond—Jan. 15, 1909. No. 2061 B.

Switzerland.

The Martigny-Châtelard Electric Railway (Elektrisch betriebene Bahn Martigny-Châtelard). S. Herzog. Illustrated detailed description of this mountain line which includes stretches on both the adhesion and rack systems. Serial. 1st part. 1000 w. Elektrotech Rundschau—Dec. 5, 1908. No. 1993 D.

Track Construction.

Methods and Cost of Constructing T-Rail Track with Carnegie Steel Ties. Utica & Mohawk Valley Ry. M. J. French. Read before the N. Y. State St. Ry. Assn. A report of work in Utica, N. Y. 1600 w. Engng-Con—Jan. 20, 1909. No. 2000.

Track Maintenance.

Some Maintenance Features of Street Railway Track. J. H. M. Andrews. Discusses joints, the facing switch, curves, frogs, etc. Ills. 2500 w. Engr, Pa—Dec., 1908. No. 2012 D.

Tracks.

The Influence of Track Upon Railway and Tramway Carriages. James Sutherland Warner. Read before the Civ & Mech. Engrs. Soc. Explains the principles upon which "Warner's lines" are based—a method of recording the riding qualities of tram cars. 4000 w. Tram & Ry Wld—Jan. 7, 1909. No. 2060 B.

Track Specifications.

Special Work Specifications of the Interstate Railways. Gives specifications adopted by a Philadelphia corporation operating lines in Pennsylvania, New Jersey and Delaware. 1000 w. Elec Ry Jour—Jan. 9, 1909. No. 1618.

Trains.

Electric Railway Rolling Stock for Urban and Suburban Service. H. M. Hobart. Estimates the weights and costs of continuous current, and single-phase trains. 1800 w. R R Age Gaz—Jan. 8, 1909. No. 1651.

Trolleys.

High Tension Current Collection—Some Results of the Swedish Electric Railway Tests. Otis Allen Kenyon. Notes on recent European practice in overhead construction and current collection, based largely on the report of recent tests made by the Swedish Government. 3500 w. Elec Ry Jour—Jan. 9, 1909. No. 1617.

Trolley Wires.

Factors Determining the Efficiency of Trolley Wire. Carl F. Woods. Abstract of a paper before the Am. Chem. Soc. States five essential qualities and methods of determining the extent wire possesses these properties. 2000 w. Elec Ry Jour—Jan. 30, 1909. No. 2134.

Trucks.

Single-Axle Flexible Trucks for Street Cars (Einachsige Drehgestelle für Strassenbahnwagen). Paul Herrmann. Refers particularly to the type of truck built by the Bergischen Stahlindustrie, Remscheid. Ills. 1500 w. Elek Kraft u Bahnen—Dec. 24, 1908. No. 1992 D.

Trunk Lines.

Electric Trunk Lines (Bahntechnische Forderungen an den elektrischen Vollbahnbetrieb). Artur Heuschka. Discusses the problems of applying electric traction to trunk line operation. Ills. Serial. 1st part. 3800 w. Zeitschr d Oest Ing u Arch Ver—Dec. 4, 1908. No. 1979 D.

Wire Suspension.

See Trolleys, under STREET AND ELECTRIC RAILWAYS.

We supply copies of these articles. See page 1071.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *w.* New York.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *n.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

THE CURRENT RECORD OF
IMPROVED MACHINERY
NEW METHODS NEW MATERIALS
NEW APPLIANCES

Ore Handling Bridge.

AT the Duquesne plant of the Carnegie Steel Company a large ore handling bridge has recently been installed by Heyl & Patterson, Inc., of Pittsburg, Pa. This is the first bridge of its type built by this company and possesses a number of interesting features. The bridge spans an ore yard of about 1,800 feet in length, serving six large blast furnaces. Adjacent to the furnaces are storage bins under which the larry cars operate to conduct the ore from the bins to the furnace skips. One supporting leg of the bridge rests on this bin structure, and the other is carried by a concrete wall 26 feet high.

The bridge is of approximately 230 feet span between trucks, and has a cantilever extension at either end of about 65 feet. The iron ore is brought within reach of the bridge by transfer cars, which operate betwen the car dumper a thousand feet or more from the ore yard and run on tracks carried by the bin structure. These transfer cars discharge their load through on open track onto baffle plates, which form a temporary pile along the bin side of the storage yard. By means of the grab bucket the bridge gathers up the ore and places it in storage or removes it from the storage pile and delivers to transfer cars for distribution into various compartments of the bins, from which the supply for their blast furnaces is drawn as needed. At the end of the bridge farther from the furnaces a "V" shaped leg furnishes the support, while at the furnace end a single shear leg supports the bridge as is shown in the accompanying illustration.

Throughout the design of this structure flexibility was sought; this provides for the inequalities in travel of the two ends of the bridge and absorbs endwise shocks and thrusts, due to the quick acceleration of the trolley, without straining the bridge.

The bridge is propelled along its track by two 52 H. P. Westinghouse type "K" crane motors; one on each truck controlled from the cab. The two controllers for the motors are set adjacent, and are so arranged that a single handle moves either controller separately or both simultaneously. This arrangement allows one end of the bridge to be moved without affecting the other, and on a long travel should one end of the bridge structure get in advance of the other end, the higher speed motor will be retarded until the slow one overtakes it.

The bucket is a 10-ton Hullett patent excavating bucket, and is operated by two 225 H. P. Westinghouse crane type motors of mill type construction. The bucket with its load of ore weighs approximately 50,000 pounds. The trolley traversing mechanism is driven by a 225 H. P. Westinghouse mill type motor, which motor is a duplicate of the two hoisting motors. The two bucket operating motors are geared together and operate by a single magnetic type controller providing also for dynamic braking; thus removing a considerable item of wear in the shape of brake blocks from the trolley. The bridge is of very high capacity, having been constructed to handle 600 tons per hour. It has, however, within the last four months far outstripped this amount.

An equipment similar in all respects to this bridge has been supplied to the Youngstown Sheet & Tube Company, Youngstown, O. This machine also is giving very high satisfaction both as to speed and maintenance.

The length of the Youngstown bridge is approximately 100 feet greater than that of the Carnegie Steel Company's, and the moving gear differs inasmuch as the bridge is propelled on its tracks by four motors instead of two, the trucks at all four corners being duplicate.

Pressed Steel Radiators.

THE new installation of heating system in the buildings of the Princeton Theological Seminary makes use of Kinnear pressed steel radiators. Consideration was given to this type of radiator on account of its light weight and compactness, the belief being that less damage would be done to the buildings in getting the radiators—many of which were large—into the rooms. It is found also that this type of radiator heats up and cools off quickly upon operating the valve. Also, when a radiator becomes frozen, which is a common occurrence in school and college buildings, no damage results either to the radiator or to the building.

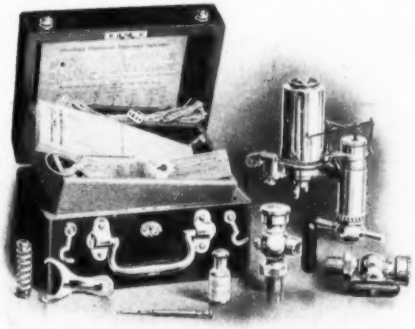
This type of radiator is made by the Pressed Radiator Co., Pittsburg, Pa.

Variable Speed Countershaft.

AN improved form of variable speed countershaft placed on the market by the Variable Speed Clutch Co., Milwaukee, Wis., presents many features of interest. The principle of the clutch mechanism is the control of air or fluid under a pressure of two to thirty pounds, and opposing centrifugal force. Existing air supply may be utilized, or a small air pump driven from the main shaft will furnish the necessary pressure, which is conveniently and readily controlled by a regulating valve near the hand of the operator. Slightly opening and closing this valve will give a machine any desired speed within the capacity of the clutch from the slowest motion to the full speed of the driver, according to the requirements of the operation. In the instance of a planer, for example, the cutting speed may be immediately increased from ten to fifty feet or more per minute. This wide range of positive control, from a mere crawl when cutting hard materials, will enable the operator to run his machine always at the maximum speed which the character of the work will permit, thereby largely increasing the capacity of a machine operated by such a clutch. The clutch may also be adjusted for work requiring a constant speed, and this speed will be maintained regardless of variations in the load. The manufacturers have issued a concise pamphlet illustrating and describing in detail the construction of the clutch and its application to many different services.

American Thompson Improved Indicator.

ACCOMPANYING is an illustration of the American Thompson improved indicator complete with fittings. The parallel motion of the American Thompson improved indicator commands special attention for its accuracy. The errors which frequently exist in drawing correct vertical lines with some indicators cannot possibly appear in the limited movement of the pencil in taking diagrams from a steam engine with this indicator. The parallel movement of the pencil is secured by a link attached to and governing the lever direct. The



pivots of this link are made free from any appreciable lost motion, and will remain so indefinitely; but if any such lost motion should exist it will affect the accuracy of the parallel movement only to an extent equal to it, not three or four times that amount.

In instruments where the parallel movement is affected by controlling the connecting rod, either by a curved slot in it and a guiding roller, or by attaching the link, the parallel movement becomes dependent for its accuracy on the fit of several parts, play in any one of which will cause an uncertainty and probable inaccuracy equal to three or four times the amount of such play.

The force required to guide the lever of the American Thompson improved indicator in its parallel movement is received on the pivots of the link alone. In cases of the slot and roller device, this guiding force is received in several rapidly moving surfaces and multiplied in amount of leverage. The same is also true to a considerable extent where the link is attached to the connecting rod.

The pencil lever, the paper cylinder movement, the leading pulley, the stem of the piston, the cylinder, the couplings and spring all hold features of interest well worth examination. The manufacturers of this indicator, the American Steam Gauge & Manufacturing Company, 208 Camden street, Boston, Mass., have issued a very instructive catalogue illustrating the indicator in all its details and explaining very fully the manner of taking diagrams, the benefits derived and information ascertained from their use. They have evolved a novel method of placing the indicator with engineers. An inquiry will bring prompt and full information.

Broken Tap Extractor.

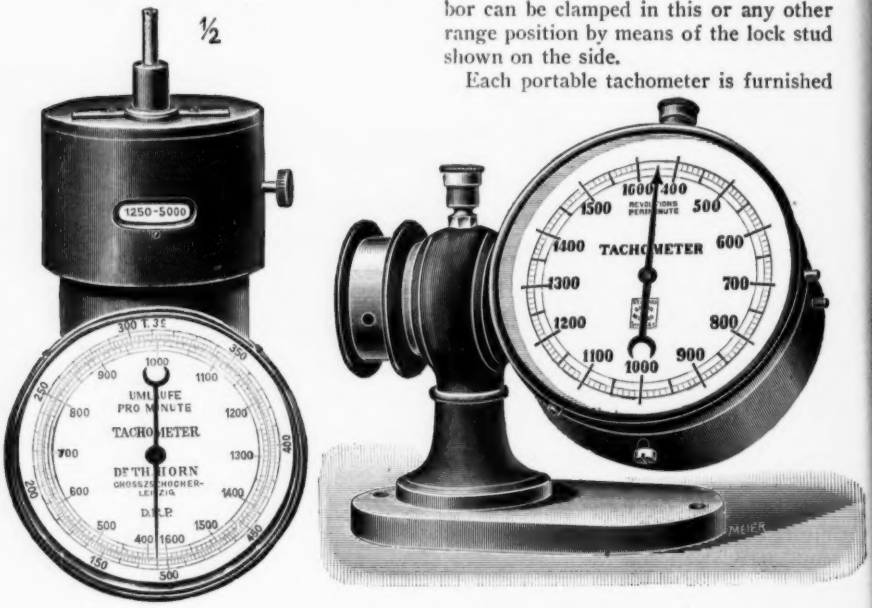
A SMALL folder issued by the Walton Company, Hartford, Conn., describes the Walton extractor of broken taps, a device for removing taps breaking at or below the surface of the work, and enables one to use taps with more freedom and confidence, as a broken tap may be easily and quickly removed from the hole without injury to the thread. It is a tool of fine workmanship throughout, and one tool may pay for itself in removing the first tap broken.

Tachometers and Tachography.

THE tachometers and tachographs here described are made in Germany by Dr. Theo. Horn in his Leipzig plant. Dr. Horn is well known on both sides of the Atlantic principally through his study of speed meters. He, like many other famous German scientists, has had the patience to devote years to the perfection of his instruments, calling to his aid in this work the highest scientific training and capacity for detail. These meters, like many of the best imported scientific instruments, display an attention to detail and finish that is scarcely possible with instruments manufactured under domestic industrial conditions. Their operation is based upon the gov-

ernor principle. The masses are so mounted on the shaft of the instrument that they, revolving with it, tend to fly off under the influence of centrifugal force. This force is, however, resisted by a spring, so that the resultant motion of the masses relative to the shaft depends upon the rate of revolution, and is indicated on a properly graduated dial or chart through a suitable link and pointer.

One of the latest improvements in the speed measuring field has been in the simplification of the portable meter. Older forms of portable tachometers had several arbors, or one for each speed range. If the approximate speed was not known, or great care was not exercised, the application of a slow speed arbor to high speed shaft would damage or destroy the instrument.



With the newly patented single arbor instrument this is impossible. There is, furthermore, no trouble in adjusting ranges or changing connecting pieces from one arbor to another. In this tachometer the arbor is carried on a slide, so that in its extreme position the highest speed is in gear. Pushing it in against the pressure of a spring throws in the next lower gear, and so on until the lowest gear is in; the arbor in this position has been pushed in to its stop. A range of from 125 to 16,000 R. P. M. can thus be automatically brought into use. In finding the correct range the arbor is pushed against the shaft until the tachometer begins to register, the figures appearing on the sight aperture indicating the range in gear. If desirable this arbor can be clamped in this or any other range position by means of the lock stud shown on the side.

Each portable tachometer is furnished in a leather case in which is mounted with it one extension piece for arbor, one steel and one india-rubber point for coupling to shafts, a rubber lined cone for coupling to spindles, and a disc for band drive if the shaft is inaccessible.

This extremely comprehensive line of scientific meters for all sorts of instrument work has been demanded by American engineers so that they have now been added to the list of instruments carried by the Industrial Instrument Company of Foxboro, Mass. The Industrial Instrument Company is now the selling company for the Standard Gauge Mfg. Co., which has for years been Dr. Horn's exclusive American agency.

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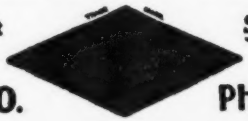

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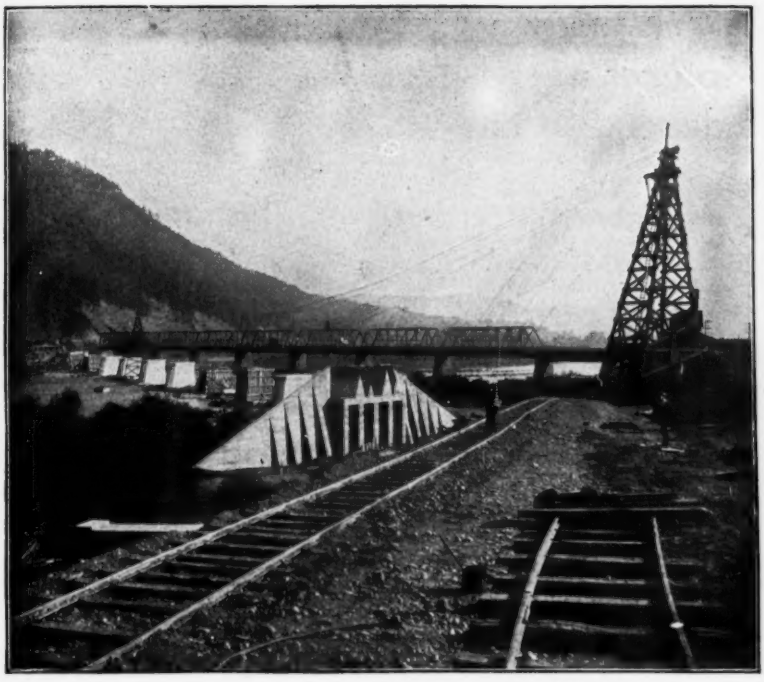

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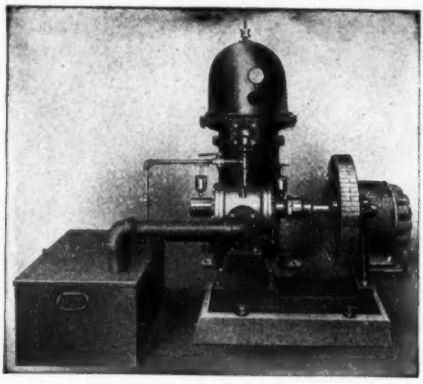

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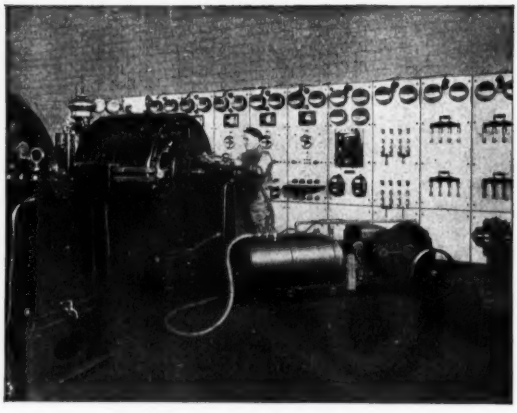

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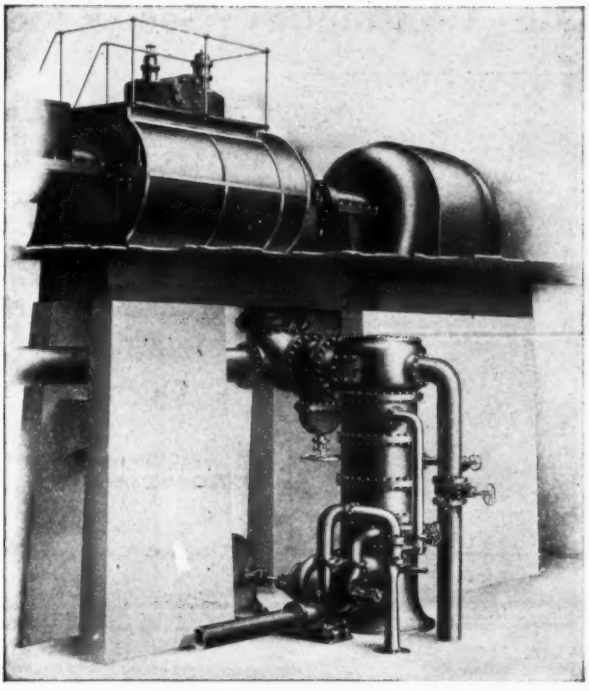

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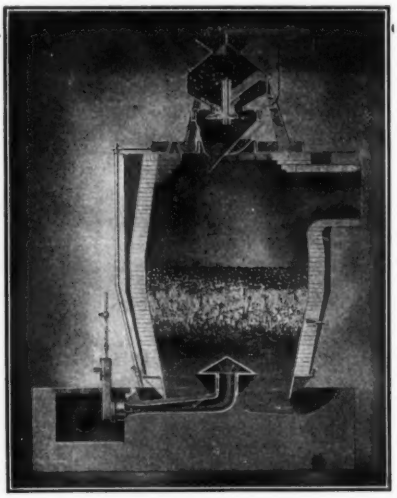

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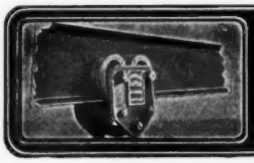

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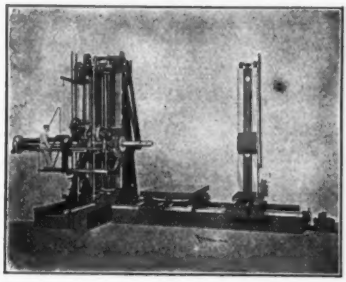

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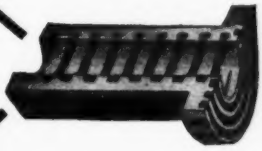

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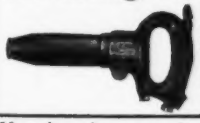

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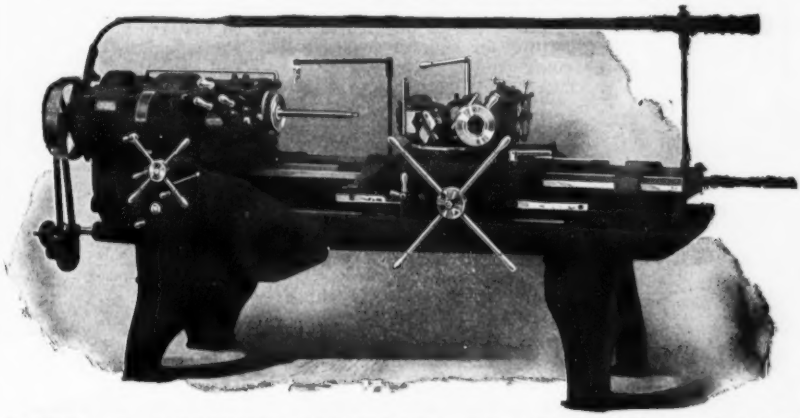

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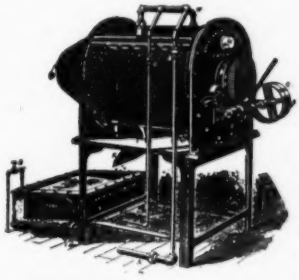

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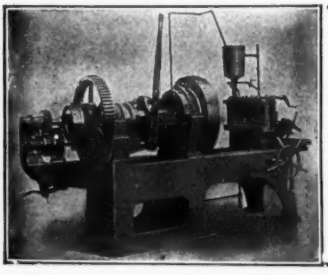

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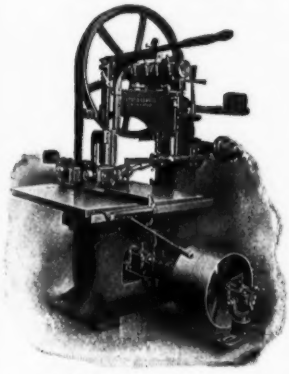

No. 180 AUT. BAND RIP SAW

Not only is it a time and labor saver over old methods, but its thin gauge blade takes out less kerf than any other machine in the market. This is owing to the fact that the machine has the most sensitive straining device known—that KNIFE-EDGE BALANCE for the upper wheel—

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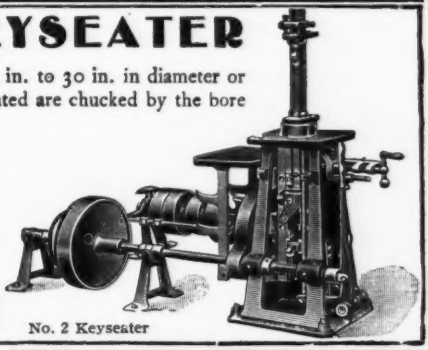

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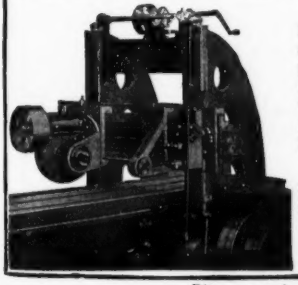

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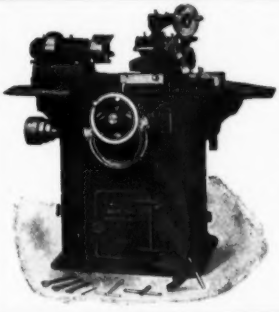

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Our No. 4 fixture is the one regularly supplied, but we have five other sizes that can be used without any change whatever in the general mechanism of the machine.

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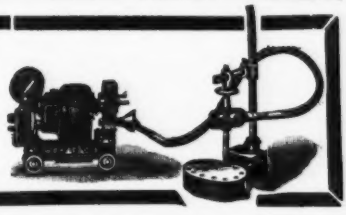

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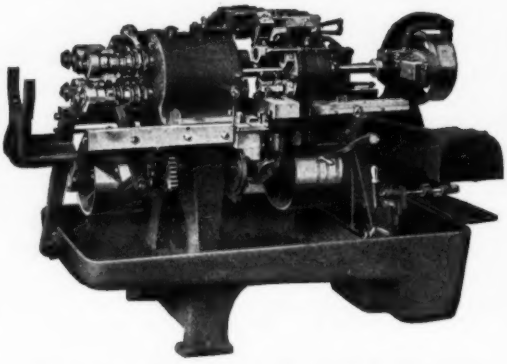

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IT increases the Production, makes the machine more powerful and reduces the cost of upkeep.—*Particulars on Request.*

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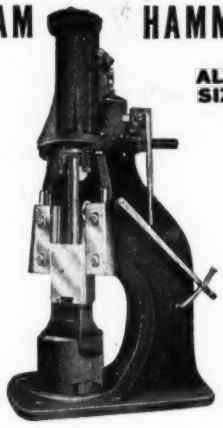

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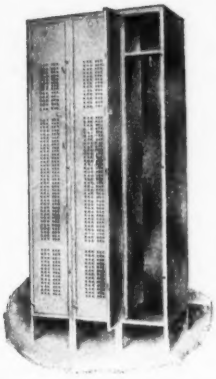

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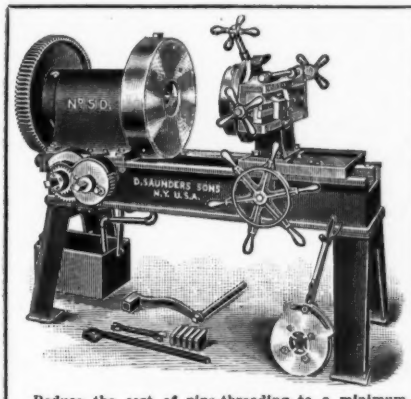

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Complete in all details, and are adapted to a very large range of work. Cut illustrates our No. 5 D Machine. Capacity, 1 to 6 inches.
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Can be used where there is moisture, heat or dust.

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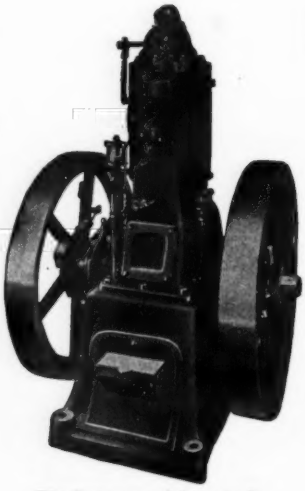

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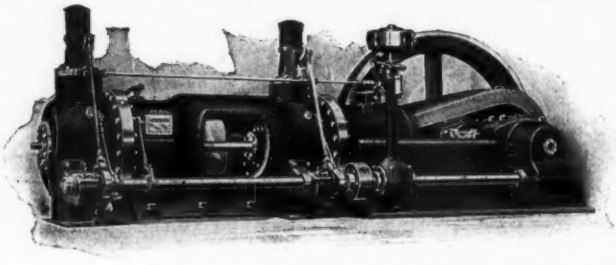

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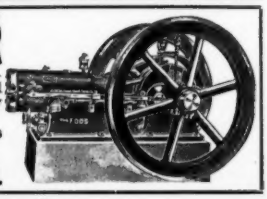

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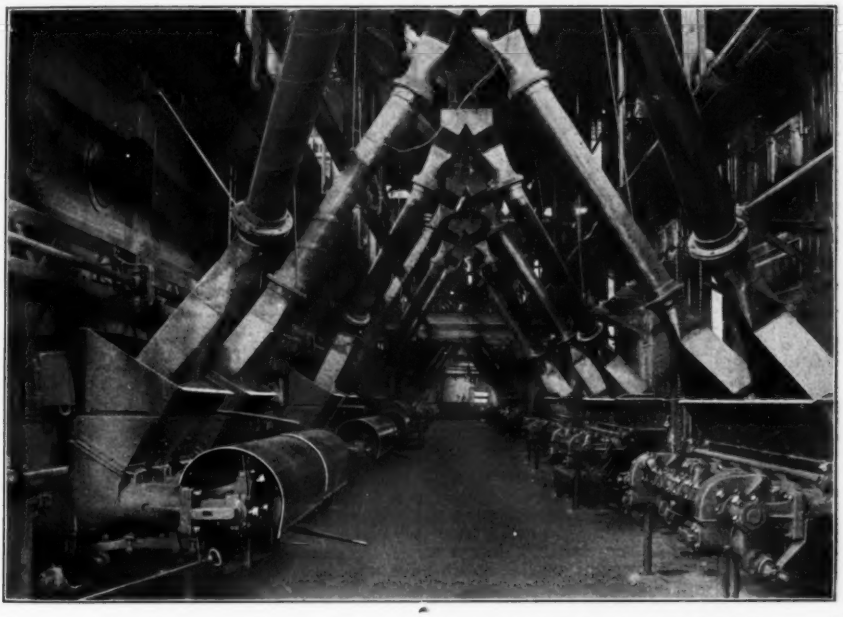

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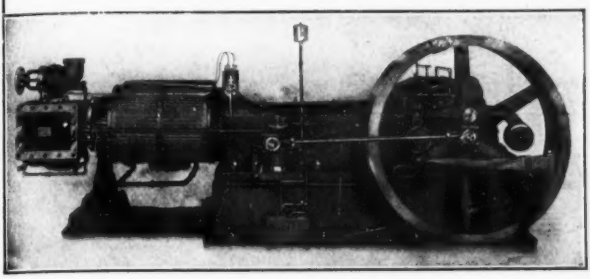

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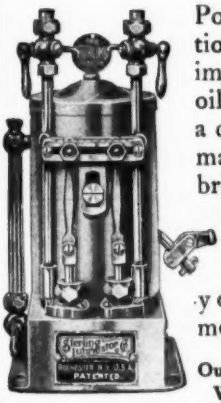

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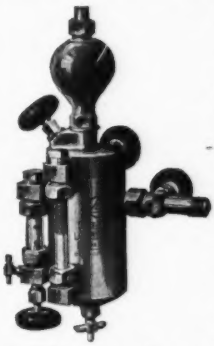

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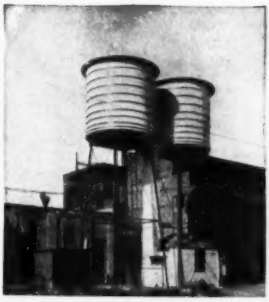

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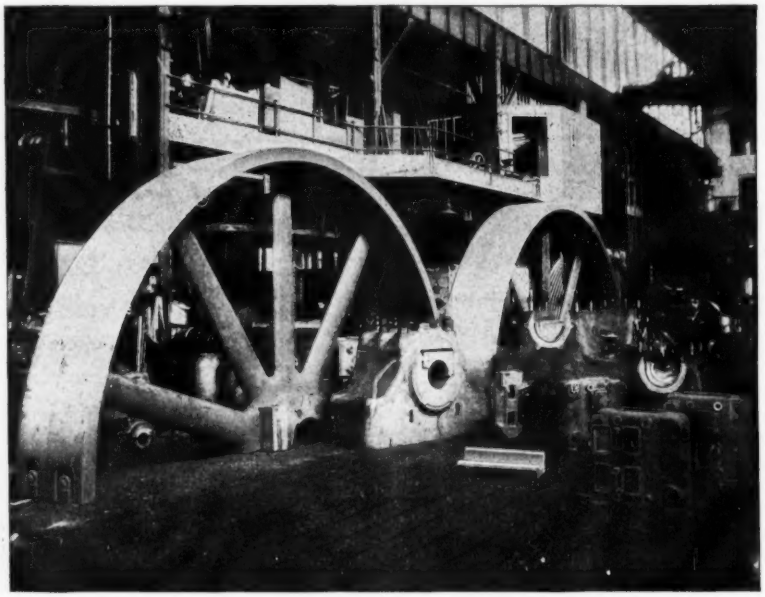

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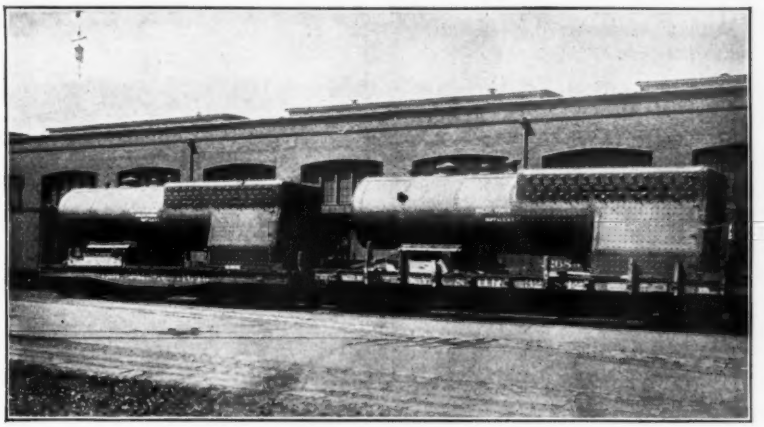

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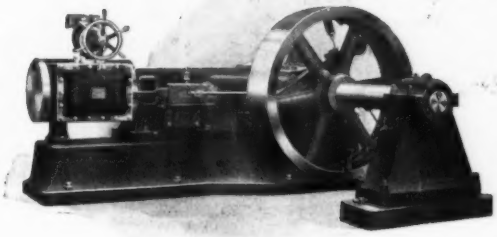

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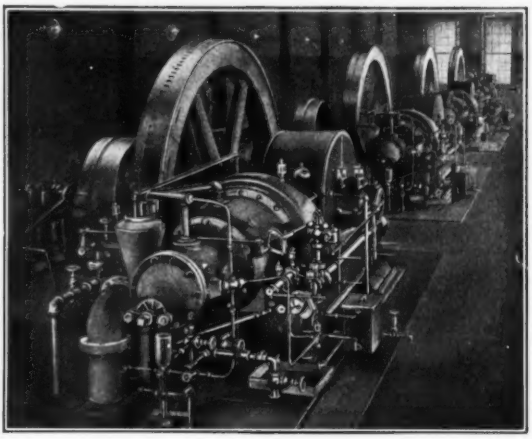

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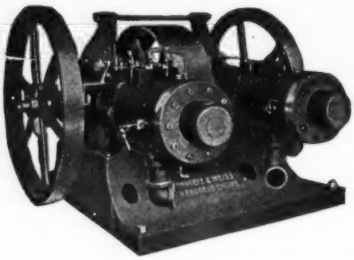

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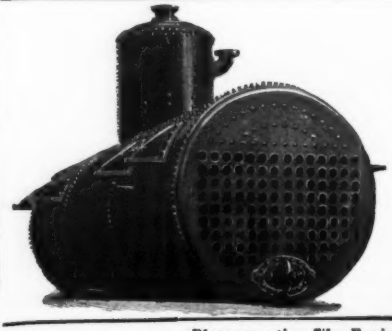

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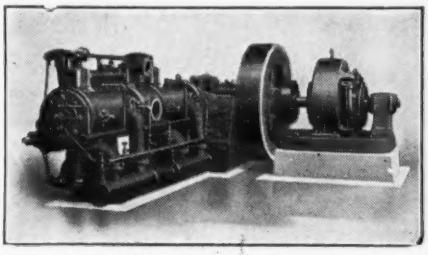

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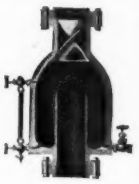

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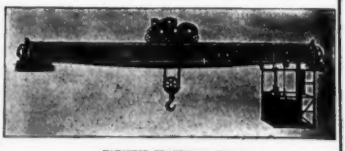

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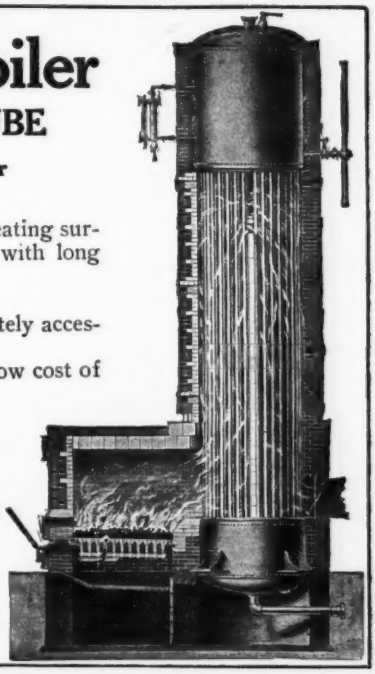

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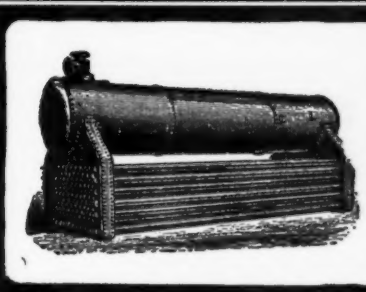

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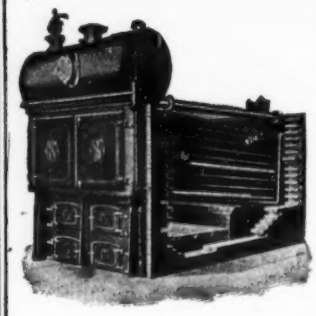

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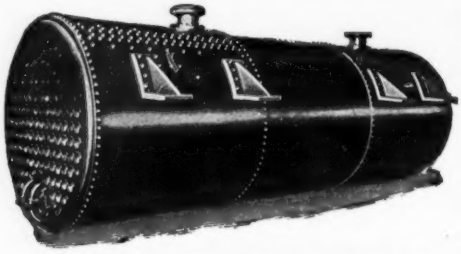

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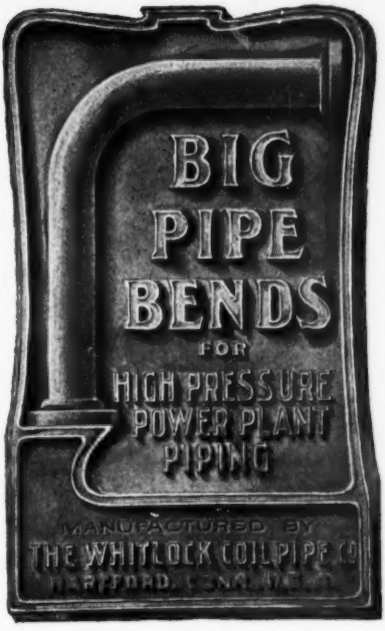

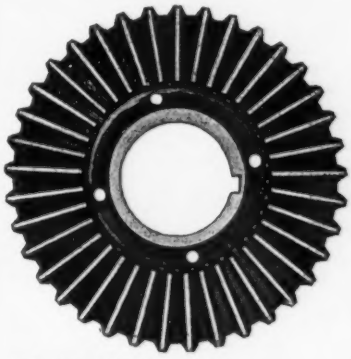

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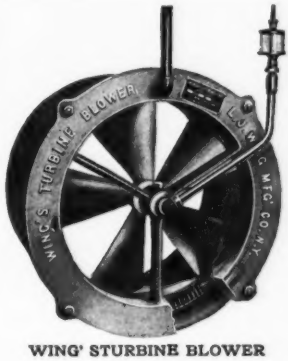

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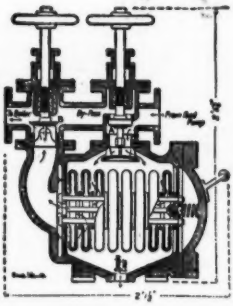

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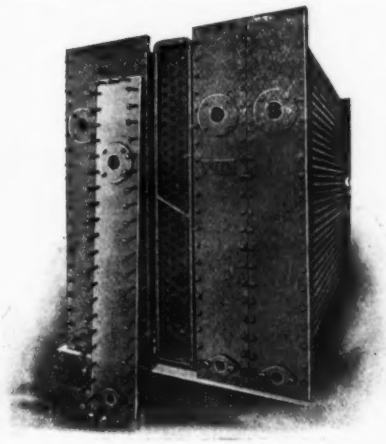

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The course of the steam through the pipes of the Green Patent Air Heater is positive and direct, that is, there is no passage from the inlet to the outlet opening except through the radiating pipes and all passages through the heater are of equal length in order to secure uniform distribution of the heating fluid. The course of the steam in travelling through these pipes is the same as the natural course of drainage of the water and air, so that the movement of the latter is assisted by the steam.

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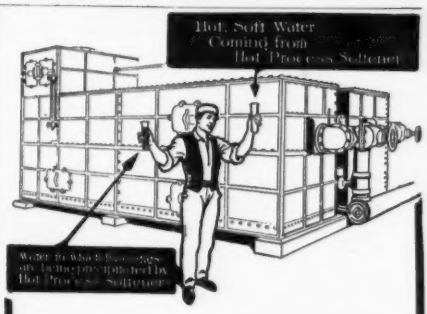

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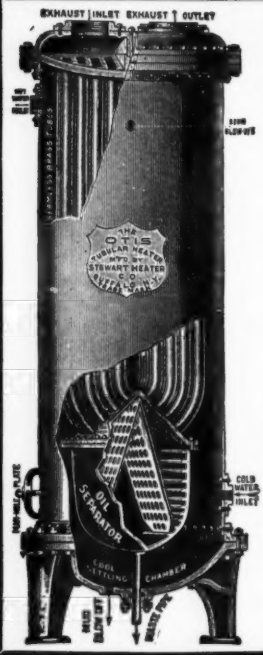

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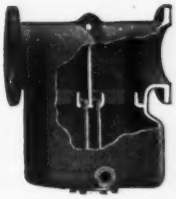

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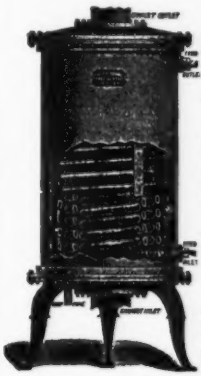

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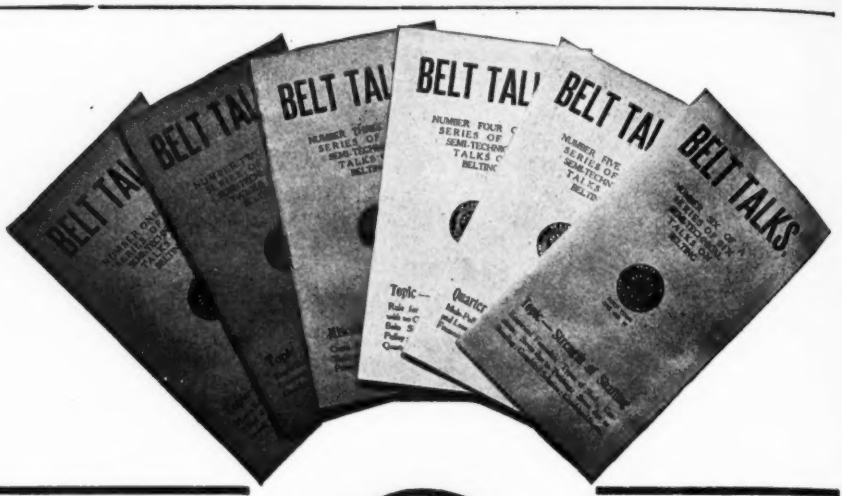

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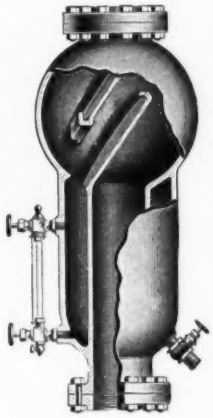

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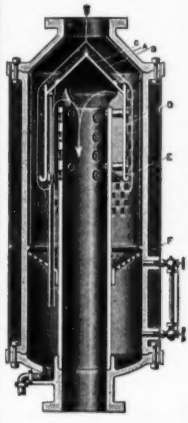

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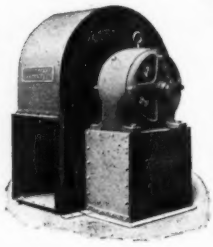

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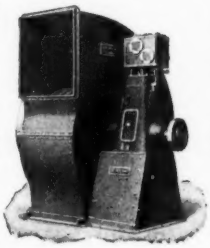

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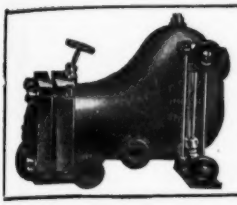

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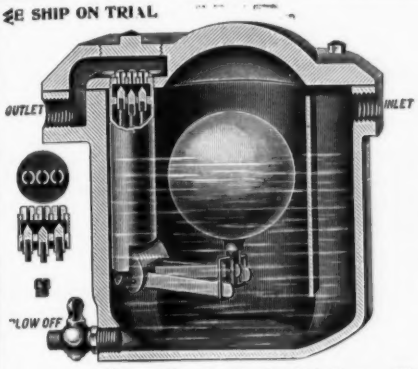

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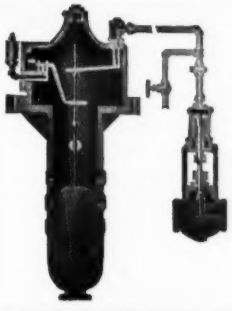

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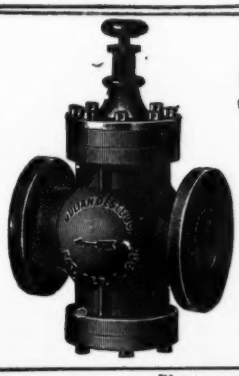

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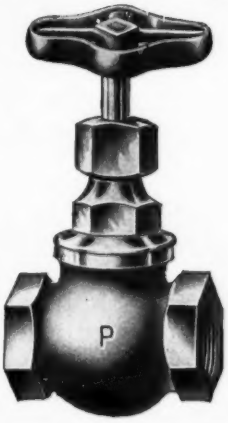

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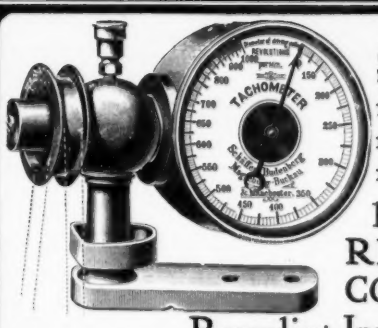

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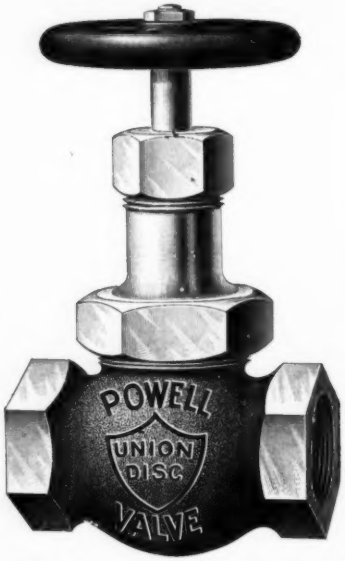

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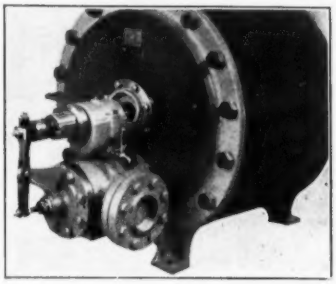

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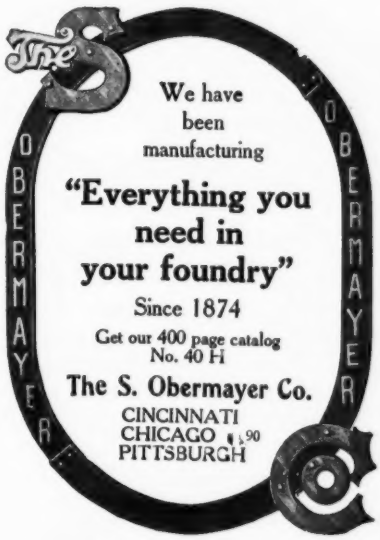

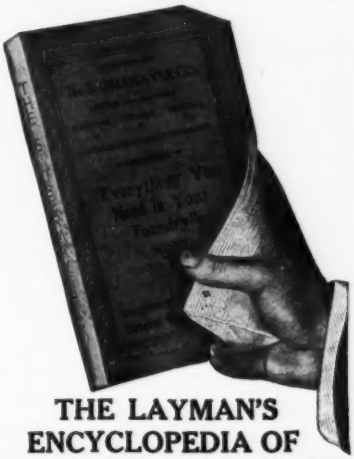

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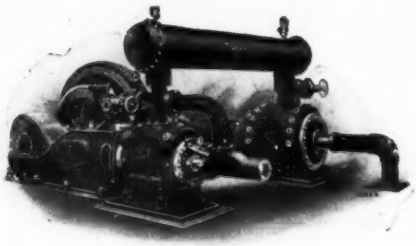

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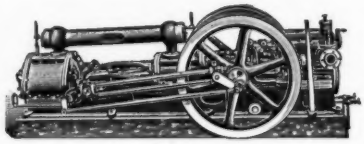

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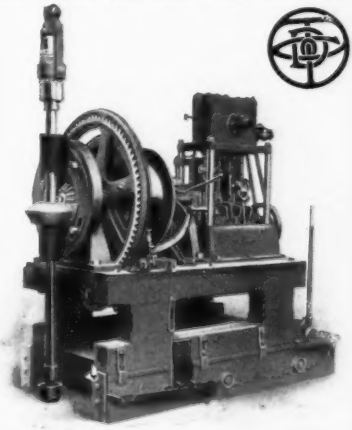

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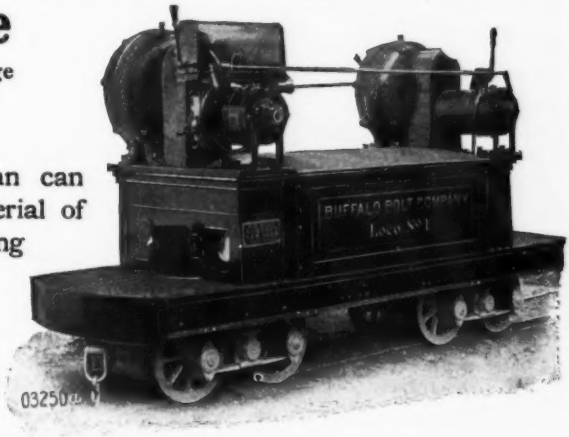

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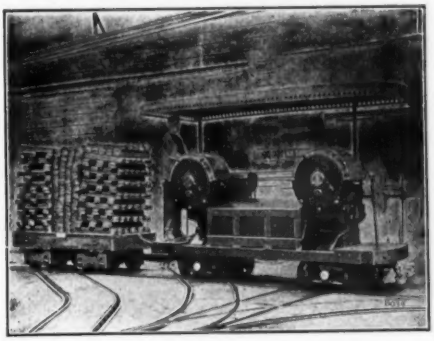

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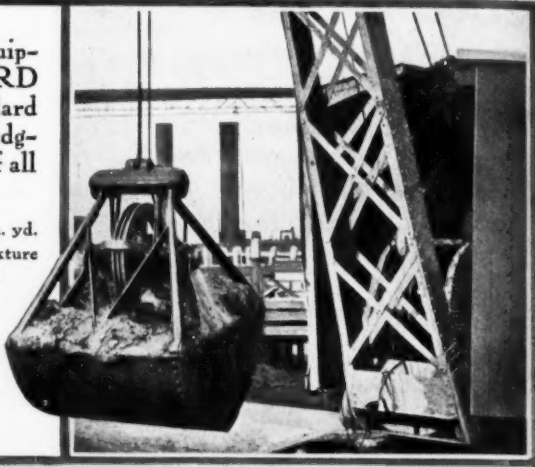

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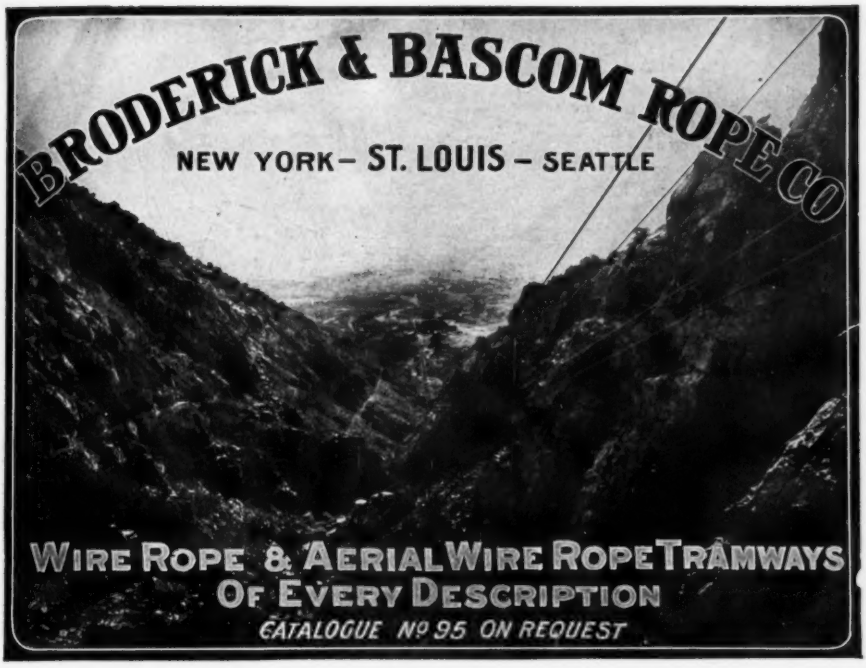
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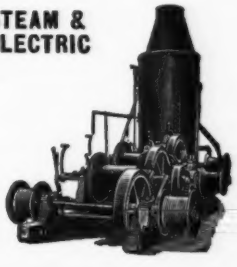

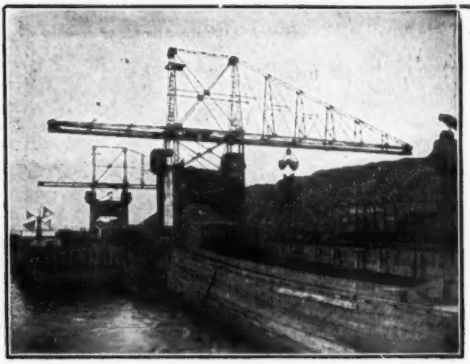

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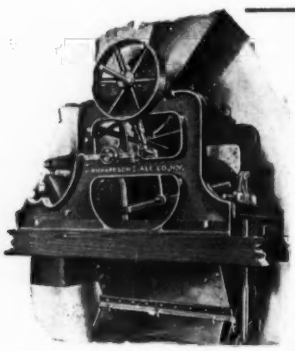

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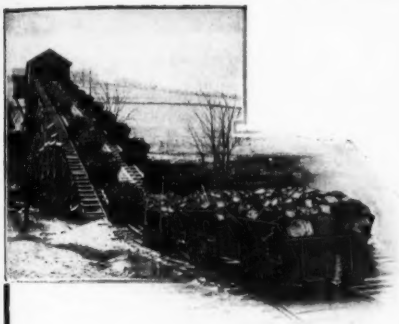

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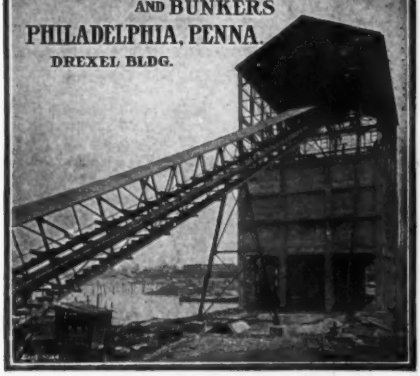

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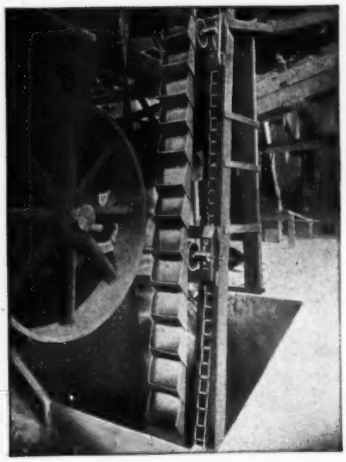

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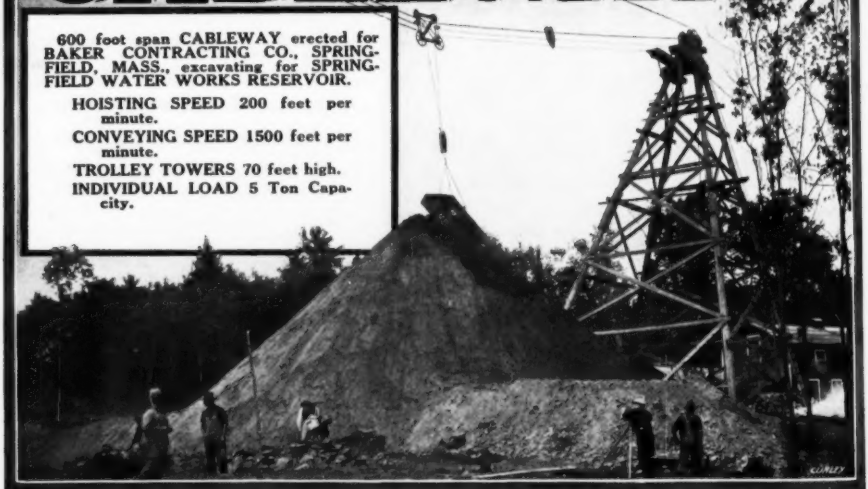

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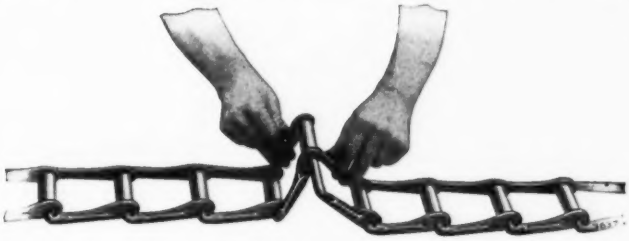

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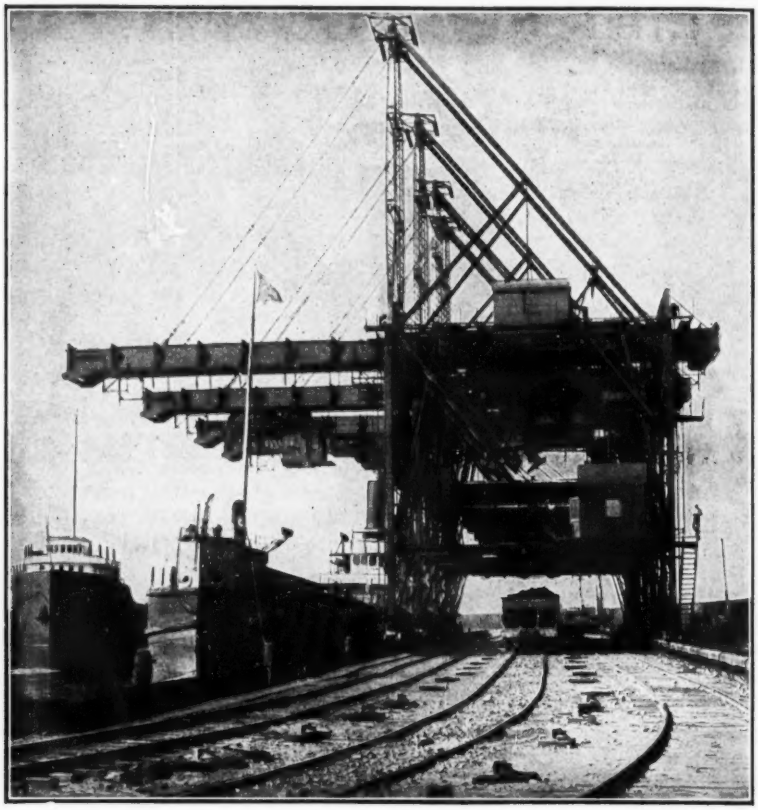

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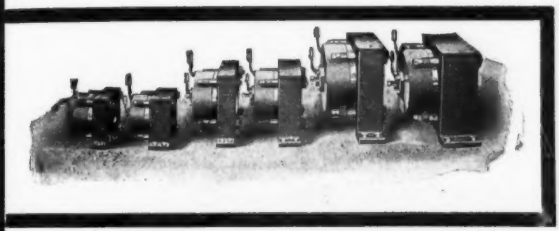

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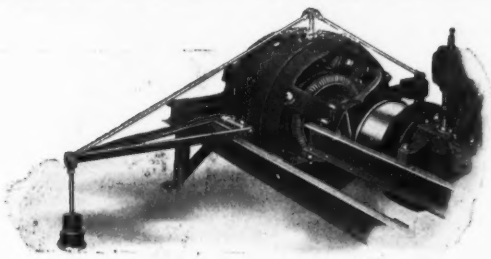

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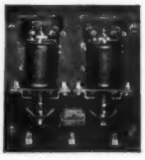

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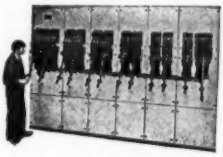

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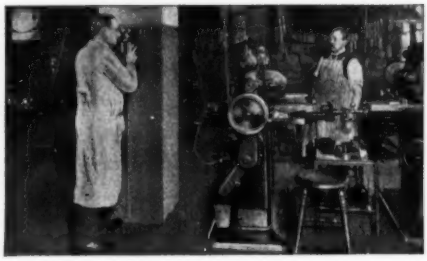

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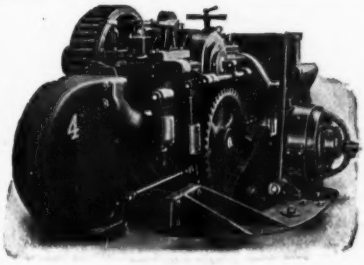

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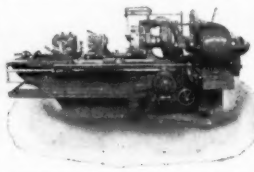

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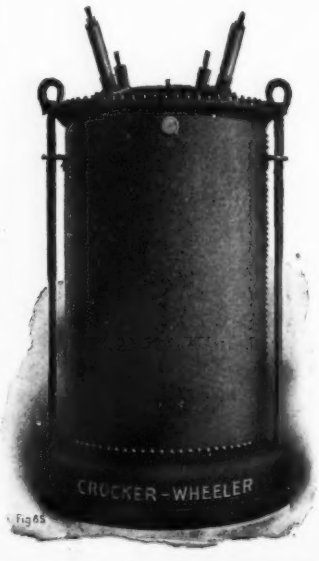

Fig 65

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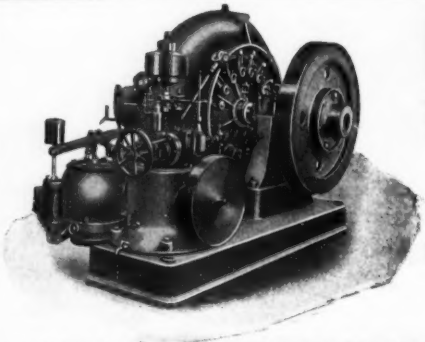

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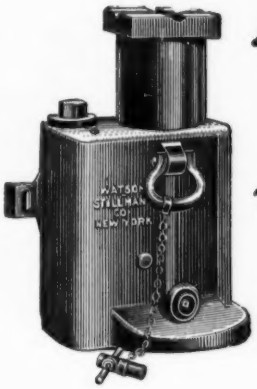

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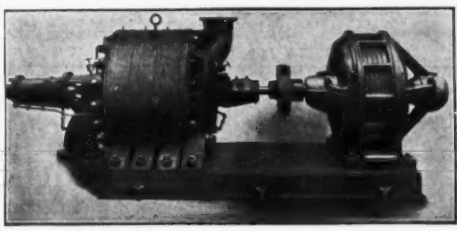

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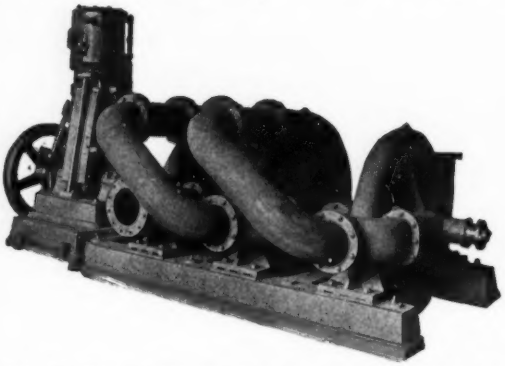

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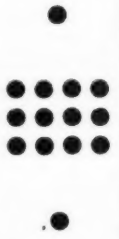

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FIG. 41.

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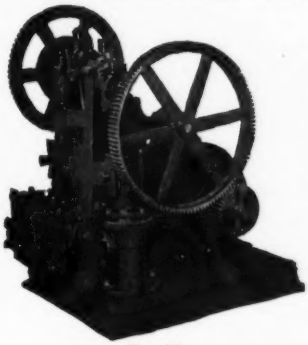

FIG. 55.

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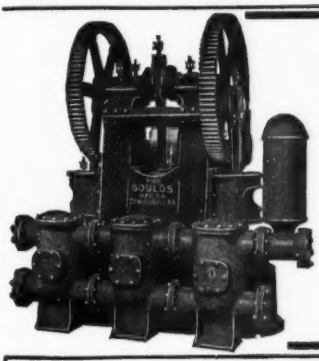

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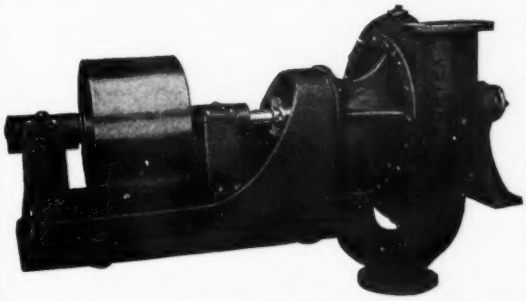

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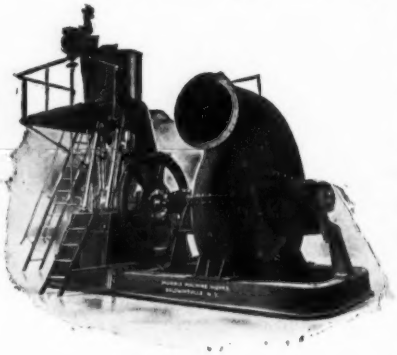

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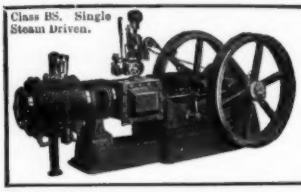

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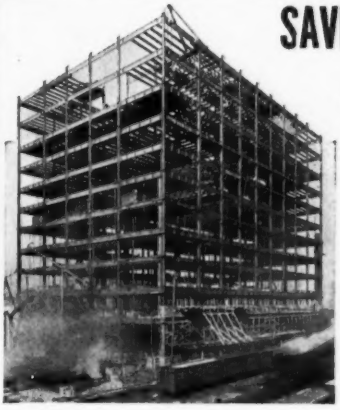

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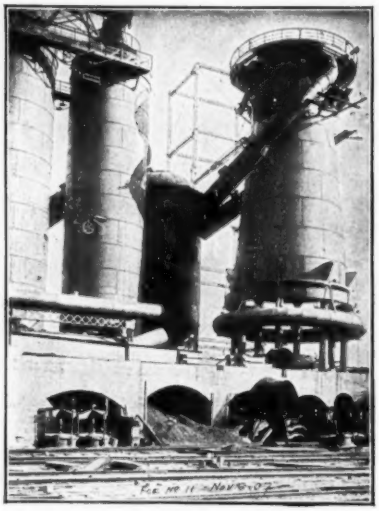

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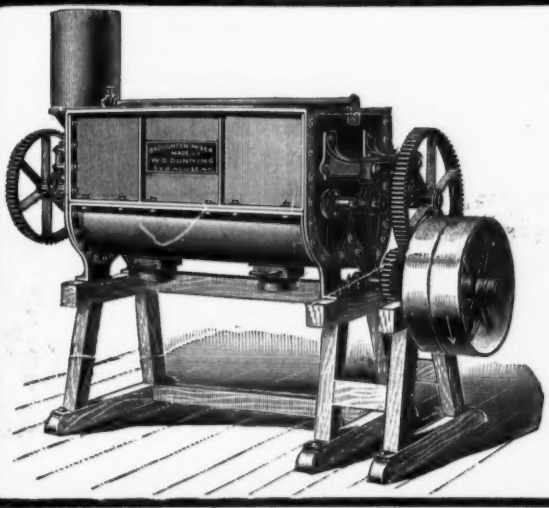

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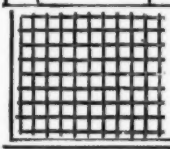

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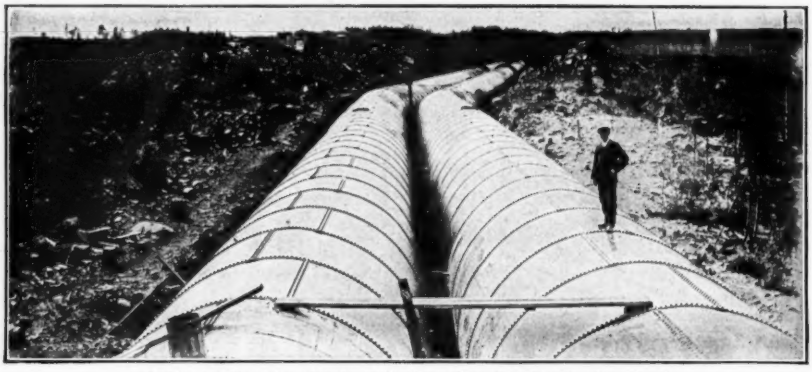

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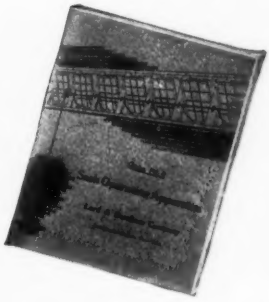

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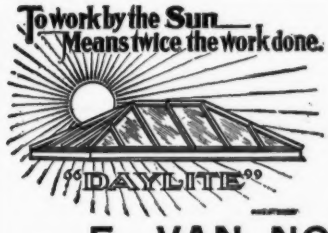

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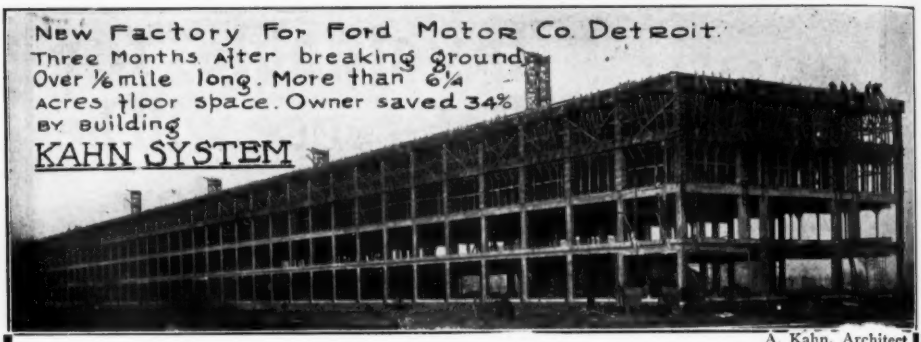
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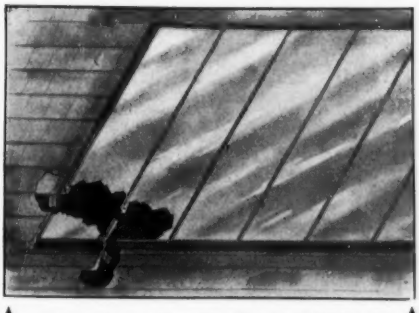

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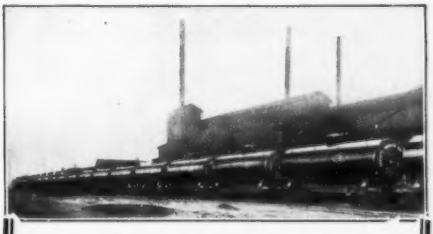

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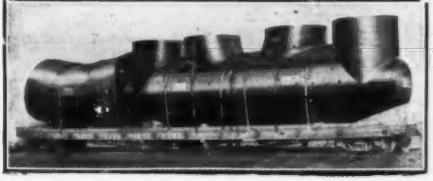

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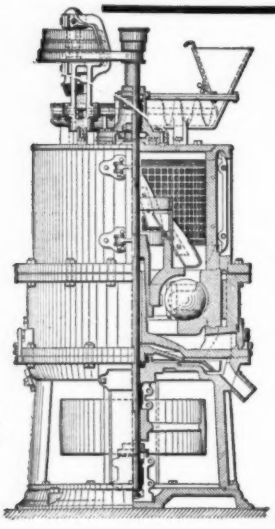

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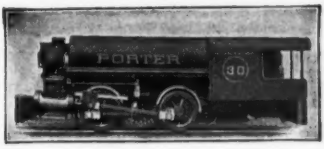

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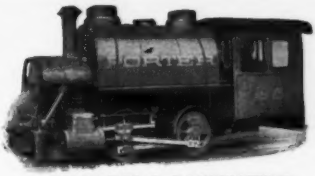

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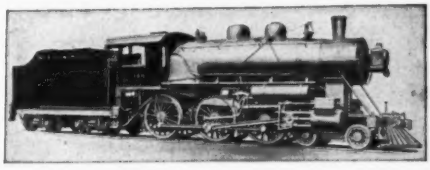

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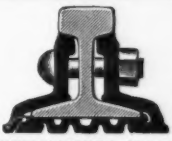

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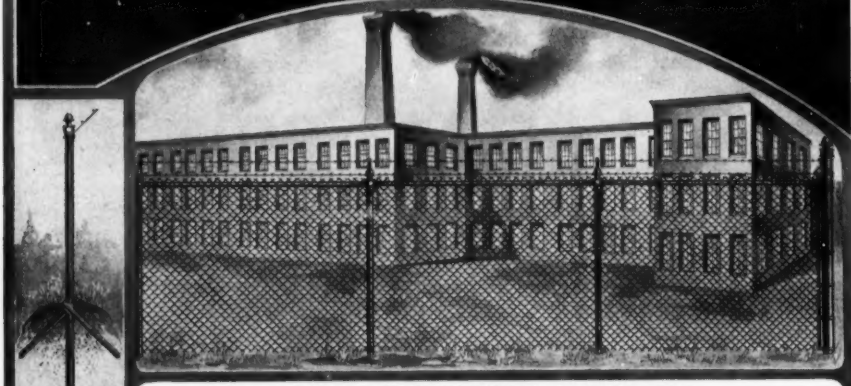

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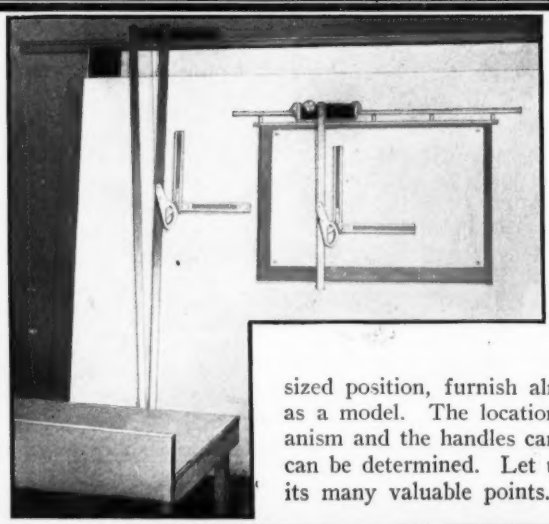

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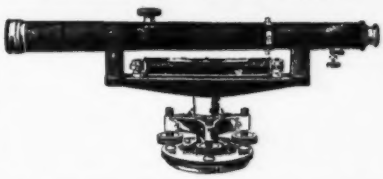

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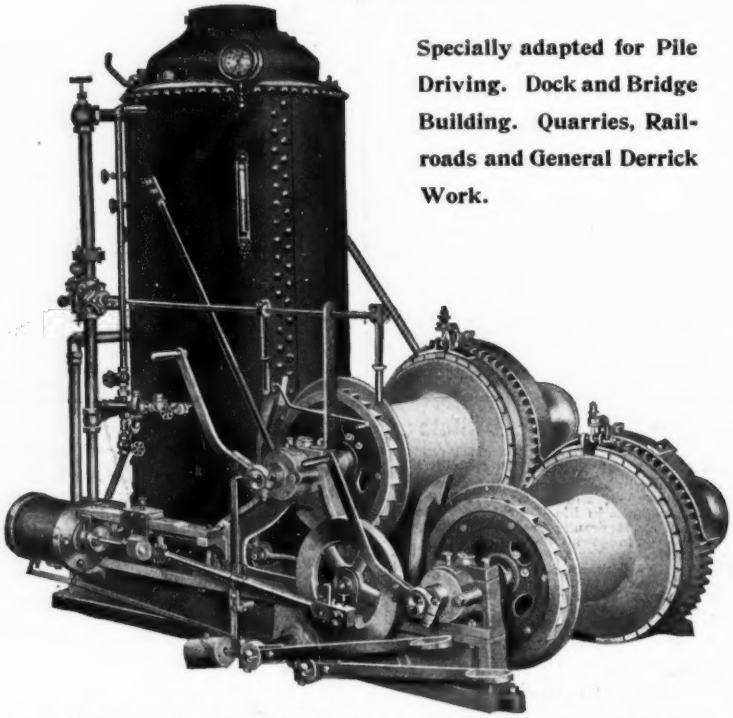

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Michigan Ry.; With Unit Costs of the Work. J. A. Stocker. Describes revisions of line and grade in Ohio, eliminating many objectionable curves. Ills. 2000 w. Eng News—Jan. 7, 1909. No. 1637.

See also Grade Reduction, under PERMANENT WAY AND BUILDINGS.

Roundhouses.

East Buffalo Roundhouse. Illustrated description of a new 30 stall roundhouse for passenger locomotives of the N. Y. C. & H. R. R. R. 3000 w. Am Engr & R R Jour—Jan, 1909. No. 1593 C.

Stations.

See Steel, under CIVIL ENGINEERING, CONSTRUCTION.

Tunnel Ventilation.

A Study of Tunnel Ventilation (Studi delle Ferrovie dello Stato sulla Ventilazione delle Galerie). An illustrated account of a study made by the Italian state railways. Serial. 1st part. 4000 w. Ing Ferro—Dec. 1, 1908. No. 1938 D.

Yards.

Gary Classification Yard of the Chicago, Lake Shore & Eastern. Gives plan and brief description of the 15000 car classification yard at Gary, Ind., and the new shop plant. 700 w. R R Age Gaz—Jan. 8, 1909. No. 1649.

TRAFFIC.

Explosives.

Safe Handling and Transportation of Explosives and Inflammables. Col. B. W. Dunn. Gives an idea of the extent of this Business Administration. 2200 w. R R of regulations wisely enforced., Ills. 10500 w. Pro Ry Club of Pittsburgh—Dec., 1008. No. 2098 C.

The American Railway Association's Bureau for the Safe Transportation of Explosives and Other Dangerous Articles. Col. B. W. Dunn. A sketch of the origin of this Bureau, the general nature of the work, and its possible lines of development. 5500 w. Pro N Y R R Club—Feb. 19, 1909. No. 2099.

MISCELLANY.

Associations.

Work of the American Railway Association. W. F. Allen. From an address on "Railway Operating Associations," delivered before the Harvard School of business, accounts of accidents, and need Age Gaz—Jan. 22. 1909. Serial. 1st part. No. 2002.

India.

A Railway to India. C. E. D. Black. Map and discussion of a projected line through Northern Arabia and Southern Persia, connecting Egypt and India. 3000 w. Nineteenth Cent—Jan., 1909. No. 1838 D.

New Zealand.

New Zealand Government Railways. A review of the report for the year ending March 31, 1908. 2500 w. Engng—Jan. 8, 1909. No. 1820 A.

Review of 1908.

Railways and Tramways. A summary of railway work in different parts of the world. 6000 w. Engr, Lond—Jan. 1, 1909. No. 1720 A.

South Africa.

The Working of the Railways in the South African War. W. Hyde Kelly. On the organization and work of a military railway staff. 4000 w. Engng—Jan. 15, 1909. No. 2079 A.

United States.

Twenty-Second Annual Report of Interstate Commerce Commission. Extracts from the report transmitted to Congress Jan. 11. 3500 w. R R Age Gaz—Jan. 15, 1909. No. 1790.

STREET AND ELECTRIC RAILWAYS

Adhesion System.

See Switzerland, under STREET AND ELECTRIC RAILWAYS.

Cars.

The Life and Wear of Rolling-Stock. M. Stahl. A report dealing with answers to questions sent out in regard to improvements in axles, wheels and tires, with a study of new types of cars. Ills. 3000 w. Elect'n, Lond—Jan. 15, 1909. Serial. 1st part. No. 2072 A.

Suggested Improvements in the Construction of Our Electric Tramways. Gerald H. J. Hooghwinkel. Presents the advantages of the single-track, single-deck car urging its adoption in England. 1500 w. Tram & Ry Wld—Jan. 7, 1909. No. 2059 B.

Combination Closed and Open Car of Pay-As-You-Enter Type for the Third Avenue Railroad Company, New York. Illustrated description of the design of new cars ordered. 3000 w. Elec Ry Jour—Jan. 23, 1909. No. 1898.

See also Track, under STREET AND ELECTRIC RAILWAYS.

Car Testing.

An Autographic Recording Apparatus for Electric Railway Tests. Albert T. Childs. Illustrated description of an autographic testing apparatus which records in curves the continuous electrical performance of a car. 1800 w. Jour Worcester Poly Inst—Jan., 1909. No. 1840 C.

Conductors.

Three-Wire System for Tramways. E. Goulding. Presents the advantages and

economics of this system. Ills. 1500 w. Tram & Ry Wld—Jan. 7, 1909. No. 2058 B.

Interurban.

New Interurban Railways in the Central States. Map and general information. 2000 w. Elec Ry Jour—Jan. 2, 1909. No. 1435.

Pittsburg, Harmony, Butler & New Castle 1200-Volt D. C. Railway. John R. Hewett. Illustrated detailed description of the electrification scheme. 2200 w. Elec Ry Jour—Jan. 16, 1909. No. 1754.

Locomotives.

Electric Locomotives for the Great Northern. Illustrates and describes the mechanical construction which is a distinct departure from previous practice. 600 w. R R Age Gaz—Jan. 15, 1909. No. 1793.

Rack Railways.

See Switzerland, under STREET AND ELECTRIC RAILWAYS.

Records.

A System of Record Keeping as Applied to Electric Railway and Tramway Equipment. R. J. M. Holmes. Outlines a card filing system of record keeping. 1000 w. Elec Rev, Lond—Jan. 15, 1909. No. 2063 A.

Substations.

See same title, under ELECTRICAL ENGINEERING, TRANSMISSION.

Subways.

Engineering Features of the Washington Street Tunnel. Illustrated description of this Boston tunnel and its relation to the rapid transit facilities. 3500 w. Engng—Jan. 15, 1909. No. 2074 A.

Arnold Report on New York Subway Traffic. The sixth report by Bion J. Arnold, dated Dec. 31, 1908. 4000 w. Elec Ry Jour—Jan. 30, 1909. No. 2133.

See also Reinforced Concrete, under CIVIL ENGINEERING, CONSTRUCTION.

Surface Contact.

The "G. B." System from a Tramway Manager's Point of View. Stanley Clegg. Read before the Inst of Elec. Engrs. Describes the system as installed at Lincoln, giving the writer's experience of it under working conditions. 7500 w. Elec Engr, Lond—Jan. 15, 1909. No. 2061 B.

Switzerland.

The Martigny-Châtelard Electric Railway (Elektrisch betriebene Bahn Martigny-Châtelard). S. Herzog. Illustrated detailed description of this mountain line which includes stretches on both the adhesion and rack systems. Serial. 1st part. 1000 w. Elektrotech Rundschau—Dec. 5, 1908. No. 1993 D.

Track Construction.

Methods and Cost of Constructing T-Rail Track with Carnegie Steel Ties, Utica & Mohawk Valley Ry. M. J. French. Read before the N. Y. State St. Ry. Assn. A report of work in Utica, N. Y. 1600 w. Engng-Con—Jan. 20, 1909. No. 2000.

Track Maintenance.

Some Maintenance Features of Street Railway Track. J. H. M. Andrews. Discusses joints, the facing switch, curves, frogs, etc. Ills. 2500 w. Engr, Pa—Dec., 1908. No. 2012 D.

Tracks.

The Influence of Track Upon Railway and Tramway Carriages. James Sutherland Warner. Read before the Civ & Mech. Engrs. Soc. Explains the principles upon which "Warner's lines" are based—a method of recording the riding qualities of tram cars. 4000 w. Tram & Ry Wld—Jan. 7, 1909. No. 2060 B.

Track Specifications.

Special Work Specifications of the Interstate Railways. Gives specifications adopted by a Philadelphia corporation operating lines in Pennsylvania, New Jersey and Delaware. 1000 w. Elec Ry Jour—Jan. 9, 1909. No. 1618.

Trains.

Electric Railway Rolling Stock for Urban and Suburban Service. H. M. Hobart. Estimates the weights and costs of continuous current, and single-phase trains. 1800 w. R R Age Gaz—Jan. 8, 1909. No. 1651.

Trolleys.

High Tension Current Collection—Some Results of the Swedish Electric Railway Tests. Otis Allen Kenyon. Notes on recent European practice in overhead construction and current collection, based largely on the report of recent tests made by the Swedish Government. 3500 w. Elec Ry Jour—Jan. 9, 1909. No. 1617.

Trolley Wires.

Factors Determining the Efficiency of Trolley Wire. Carl F. Woods. Abstract of a paper before the Am. Chem. Soc. States five essential qualities and methods of determining the extent wire possesses these properties. 2000 w. Elec Ry Jour—Jan. 30, 1909. No. 2134.

Trucks.

Single-Axle Flexible Trucks for Street Cars (Einachsige Drehgestelle für Strassenbahnwagen). Paul Herrmann. Refers particularly to the type of truck built by the Bergischen Stahlindustrie, Remscheid. Ills. 1500 w. Elek Kraft u Bahnen—Dec. 24, 1908. No. 1992 D.

Trunk Lines.

Electric Trunk Lines (Bahntechnische Forderungen an den elektrischen Vollbahnbetrieb). Artur Heuschka. Discusses the problems of applying electric traction to trunk line operation. Ills. Serial. 1st part. 3800 w. Zeitschr d Oest Ing u Arch Ver—Dec. 4, 1908. No. 1979 D.

Wire Suspension.

See Trolleys, under STREET AND ELECTRIC RAILWAYS.

We supply copies of these articles. See page 1071.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *w.* New York.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Gen. d Ferrovie *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *n.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

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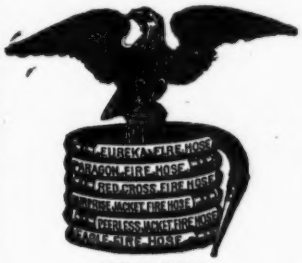

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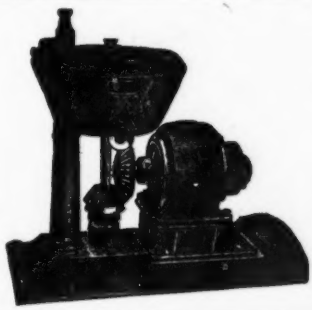

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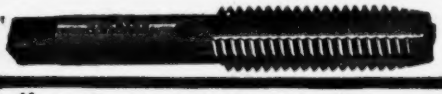

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